THE PHYLOGENETIC TAXONOMY OF FLOWERING PLANTS

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I. General Discussion

Seventeen years ago in presenting a somewhat similar paper[1] to a smaller body of botanists, I began by saying that "it is as yet impossible to present a complete phylogeny of the angiosperms," and then a little later, "it will be many a year before the direct evidence we so much desire will leave no considerable gaps," and I am impelled to use the same words now as I begin this discussion to-day. For, while in this interval paleontology has uncovered many important facts whose significance is unmistakable, it is still true that there are "considerable gaps" in the record of the evolution of plants, both before and after the attainment of flower production. In other words, we are still in quest of direct testimony as to how flowers came into existence in particular, and as to the details of how and when they were modified afterwards. Yet we are not wholly without the direct testimony of the rocks in our inquiry as to the phylesis of the higher plants.

And I may be permitted here to enter a defense of such a discussion as I propose to make in this paper, in reply to those who think that since much of what I shall have to say is reached by a process of deduction, or, as it is more commonly called, speculation, it can have little scientific value. And I grant that in those fields where direct observation, experiment, and induction are possible there can be no defense of the exclusive deductive or speculative method. There are, however, many fields of botanical inquiry in which experiment is impossible, and observation is reduced to a minimum, and this

[1] Bessey, C. E. The phylogeny and taxonomy of angiosperms. (Address of the retiring president of the Botanical Society of America, at its third annual meeting, at Toronto, Canada, August 17, 1897.) Bot. Gaz. **24**: 145–178. *f. 1–3.* 1897.

is necessarily the case when we are dealing with questions which relate to periods of time long past, as must be those involving phylogeny.

Moreover, it must not be forgotten that what I propose to do is after all much like what is done in even those sciences which we sometimes call the exact sciences. The ether of space, the undulatory theory of light, the tentative hypotheses as to the nature of electricity and gravitation, the form and extent of the universe, and the constitution of matter itself, are a few of the familiar speculations which physicists, astronomers and chemists have made parts of the conceptions of their respective sciences. To be sure, one can go but a short distance indeed in any science without finding it necessary to erect a speculative framework upon which to arrange his observed facts. As Jevons has so aptly expressed it in his 'Principles of Science' (2: p. 131):

> "When facts are already in our possession, we frame an hypothesis to explain their mutual relations, and by the success or non-success of this explanation is the value of the hypothesis to be entirely judged. In the framing and deductive treatment of such hypotheses, we must avail ourselves of the whole body of scientific truth already accumulated, and when once we have obtained a probable hypothesis, we must not rest until we have verified it by comparison with new facts. * * * Out of the infinite number of observations and experiments which are possible at every moment, theory must lead us to select those few critical ones which are suitable for confirming or negativing our anticipations."

A little later (p. 137) he remarks:

> "The true course of inductive procedure is that which has yielded all the more lofty and successful results of science. It consists in anticipating Nature, in the sense of forming hypotheses as to the laws which are probably in operation; and then observing whether the combinations of phenomena are such as would follow from the laws supposed. The investigator begins with facts and ends with them. He uses such facts as are in the first place known to him in suggesting probable hypotheses; deducing other facts which would happen if a particular hypothesis is true, he proceeds to test the truth of his notion by fresh observations or experiments. If any result prove different from what he expects, it leads him either to abandon, or to modify his hypothesis; but every new fact may give some new suggestion as to the laws in action."

I may quote one more sentence from the Manchester logician (p. 138): "Agreement with fact is the one sole and sufficient test of a true hypothesis."

So I come with a general hypothesis of the evolution of living things, and of plants in particular. This hypothesis is based upon observed facts, which are here given such a uniform interpretation as will make my general hypothesis, and it is this latter that I wish to discuss to-day, making such application as will enable us to arrange the flowering plants in accordance with it.

I am going to confine my discussion pretty largely to the plants of the highest phylum, here restricted to those that bear flowers. Since the discovery of the pteridosperms, it is manifestly untenable to regard all seed-bearing plants as members of one phylum. In other words, the *Spermatophyta* of the books constitute not one phylum, but several phyla. Briefly, I shall exclude first of all the cycad phylum which began in the Paleozoic period with the pteridosperms, and has extended with many losses to the present. I shall also exclude the conifer phylum, related to but not included in the cycad phylum. These two phyla are commonly associated in a group under the name of gymnosperms, but I have no hesitation in keeping them as distinct phyla, the cycads lower, and the conifers higher.

The remaining seed-bearing plants, whose seeds are enclosed in carpels, constituting the old group of angiosperms, I regard as a distinct phylum, and because the flower is the dominant and characteristic structure, I designate them as the Phylum *Anthophyta,* and they are the flowering plants about which I speak to-day.

So in clearing the way for this discussion, let me show the relationship of these three phyla of higher plants by means of an analytic key, as follows:

A. Gametophyte generation larger, and longer-lived than the dependent sporophyte generation. Here are set off the liverworts and mosses.

B. Gametophyte generation smaller and shorter-lived than the independent sporophyte generation.

(a) Here we set off those plants in which both generations are mostly holophytic and independent of one another, the megagametophyte still containing chlorophyll, including ferns, calamites, and lycopods.

(b) Gametophytes hysterophytic, dependent upon, and nourished by, the sporophytes, the megagametophyte not containing chlorophyll.

(1) Megagametophyte a fully developed cellular mass before the formation of the eggs; microgametophytes few-celled; antherids basicidal; sperms ciliated and motile; megasporophylls open, in simple spirals to simple strobili; seeds fleshy; microsporophylls mostly multisporangiate; bundles tracheidal, in a small, little-enlarging cylinder; pith and cortex large; stems simple; leaves ample, mostly pinnate, persistent, veins parallel .....CYCAD PHYLUM

(2) Megagametophyte a fully developed cellular mass before the formation of the eggs; microgametophytes few (to one)-celled; antherid apicidal; sperms non-ciliated and not visibly motile; megasporophylls open, in well-developed strobili; seeds not fleshy; microsporophylls with few (2–8) sporangia; bundles tracheidal, in an enlarging cylinder; pith and cortex small; stems branched; leaves small, simple, persistent, veins parallel .....CONIFER PHYLUM

(3) Megagametophyte fully developed as a cellular mass (endosperm) only after the fertilization of the egg; microgametophytes one-celled; antherids apicidal; sperms non-ciliated and not visibly motile; megasporophylls closed (carpels), in floral strobili (flowers), often much reduced; seeds not fleshy; microsporophylls (stamens) with four sporangia; bundles fibrovascular, in an enlarging cylinder; pith and cortex small (or bundles scattered and stem non-enlarging); stems branched; leaves mostly large, simple to compound, persistent to deciduous, veins netted to parallel .....FLOWERING PLANT PHYLUM

In the foregoing analysis, I have emphasized the similarities rather than the dissimilarities between the plants of these phyla, and such a statement will serve to show that they are related, and yet no one can compare them and not be forced to the conclusion that they must have diverged from one another at an early period in their evolution. And this divergence is to be interpreted as involving the cycad phylum as the primitive group from which have sprung the conifers on the one hand and the flowering plants on the other.

Following the plan which I adopted in my earlier paper,[1] I may here designate a number of generally accepted principles of classification as they apply to the flowering plants. While generally accepted, these principles have rarely if ever been formulated by taxonomists or others, so that as here formulated they may create some surprise and perhaps some opposition.

For the sake of brevity I give them in the form of dicta, as follows:

A. GENERAL DICTA

1. Evolution is not always upward, but often it involves degradation and degeneration.

[1] *Loc. cit.*

2. In general, homogeneous structures (with many and similar parts) are lower, and heterogeneous structures (with fewer and dissimilar parts) are higher.
3. Evolution does not necessarily involve all organs of the plant equally in any particular period, and one organ may be advancing while another is retrograding.
4. Upward development is sometimes through an increase in complexity, and sometimes by a simplification of an organ or a set of organs.
5. Evolution has generally been consistent, and when a particular progression or retrogression has set in, it is persisted in to the end of the phylum.
6. In any phylum the holophytic (chlorophyll-green) plants precede the colorless (hysterophytic) plants, and the latter are derived from the former.
7. Plant relationships are *up and down* the genetic lines, and these must constitute the framework of phylogenetic taxonomy.

B. DICTA HAVING SPECIAL REFERENCE TO THE GENERAL STRUCTURE OF THE FLOWERING PLANTS

8. The stem structure with collateral vascular bundles arranged in a cylinder is more primitive than that with scattered bundles, and the latter are to be regarded as derived from the former.
9. Woody stems (as of trees) are more primitive than herbaceous stems, and herbs are held to have been derived from trees.
10. The simple, unbranched stem is an earlier type, from which branching stems have been derived.
11. Historically the arrangement of leaves in pairs on the stem is held to have preceded the spiral arrangement in which the leaves are solitary at the nodes.
12. Historically simple leaves preceded branched (''compound'') leaves.
13. Historically leaves were first persistent (''evergreen'') and later deciduous.
14. The reticulated venation of leaves is the normal structure,

and the parallel venation of some leaves is a special modification derived from it.

C. DICTA HAVING REFERENCE TO THE FLOWERS OF FLOWERING PLANTS

15. The polymerous flower structure precedes, and the oligomerous structure follows from it, and this is accompanied by a progressive sterilization of sporophylls.
16. Petaly is the normal perianth structure, and apetaly is the result of perianth reduction (aphanisis).
17. The apochlamydeous perianth is earlier and the gamochlamydeous perianth is derived from it by a symphysis of the members of perianth whorls.
18. Actinomorphy is an earlier structure than zygomorphy, and the latter results from a change from a similar to a dissimilar growth of the members of the perianth whorls.
19. Hypogyny is the more primitive structure, and from it epigyny was derived later.
20. Apocarpy is the primitive structure, and from it syncarpy was derived later.
21. Polycarpy is the earlier condition, and oligocarpy was derived from it later.
22. The endospermous seed is primitive and lower, while the seed without endosperm is derived and higher.
23. Consequently, the seed with a small embryo (in endosperm) is more primitive than the seed with a large embryo (in scanty or no endosperm).
24. In earlier (primitive) flowers there are many stamens (polystemonous) while in later flowers there are fewer stamens (oligostemonous).
25. The stamens of primitive flowers are separate (apostemonous), while those of derived flowers are often united (synstemonous).
26. The condition of powdery pollen is more primitive than that with coherent or massed pollen.
27. Flowers with both stamens and carpels (monoclinous) precede those in which these occur on separate flowers (diclinous).

28. In diclinous plants the monoecious condition is the earlier, and the dioecious later.

Let us now endeavor to apply these principles candidly in an attempt to secure a phyletic taxonomy of the flowering plants.

As a consequence, we begin with the plants that are primitively opposite-leaved, as shown by their first leaves ("cotyledons") that are always opposite. These are what we have known as dicotyledons. But this name, which was once significant, is no longer useful, and in fact has become somewhat misleading, so that I propose to substitute for it the name *Oppositifoliae* for the first class of the *Anthophyta.* Likewise for the other class, hitherto known as the monocotyledons, in which the leaves are alternate from the first, and continue so throughout the whole plant body, I propose the more appropriate name of *Alternifoliae.*

In considering these two classes, it is quite evident that the first is not only the larger in the number of its species, but also that it includes many more important modifications of structure than does the other. Yet there is much similarity in the kinds of modification of structure in the two classes, the larger class, from its very largeness, including many more details of modification and variation.

In both classes we begin with apocarpous plants, and proceed toward those that are syncarpous. So the *Ranales* on the one hand, and the *Alismatales* on the other, are near the point of beginning. In one class syncarpy is attained after the passing of a few hundred species (*Alismatales,* 409 species), while in the other it is not reached until much beyond the limits of the order *Ranales,* for it is well known that the syncarpy of many *Malvales* and *Geraniales* is distinctly incomplete, the coherence between the carpels being so feeble that they readily separate at maturity. All told, fully 10,000 species of this class are passed before complete syncarpy is attained.

The strobiloid flower structure, in which the axis is elongated, cylindrical, spheroidal, or flattened, bearing on its sur-

face the fertile and sterile sporophylls, prevails in the earlier orders of both classes, in the smaller, continuing through the *Alismatales, Liliales, Arales, Palmales,* and *Graminales,* and aggregating more than 11,700 species. In the larger class the strobiloid structure prevails throughout fourteen orders, from the *Ranales* to the *Lamiales,* and aggregating more than 53,000 species. In these strobiloid flowers, as a result of the dominance of the strobilar structure, we have what has been known as the hypogynous form of flower. In both classes the strobiloid flowers show progressive modifications involving the perianth (actinomorphy to zygomorphy, diplochlamydy to achlamydy), the stamens (polystemony to oligostemony), the carpels (polycarpy to oligocarpy), the ovules (multiovulate to rariovulate). In the larger class the perianth modifications proceed with such regularity that we may recognize lower (apopetalous), and higher (sympetalous) groups of orders, but this is not observed in the smaller class, where indeed sympetaly is never more than sporadic, and does not become a fixed structure.

In summary fashion I may now outline the taxonomy of the flowering plants:

The opposite-leaved class (*Oppositifoliae,* or dicotyledons) is the first to emerge from the cycadean phylum, appearing as the ranalean complex.

From this Ranalean type arises the alternate-leaved class of flowering plants (*Alternifoliae,* or monocotyledons) as apocarpous *Alismatales,* and these soon merge into the syncarpous *Liliales,* which are successively more and more modified in the *Arales, Palmales* and *Graminales.* From *Liliales* by a cotyloid modification the mostly actinomorphic epigynous *Iridales* are derived, and from these again the zygomorphic epigynous *Orchidales.*

Returning to the *Ranales,* we find that they give rise first to five apopetalous, polycarpellate orders with gradually increasing syncarpy, namely *Malvales, Geraniales, Guttiferales, Rhoeadales,* and *Caryophyllales.* From the last arise three orders of sympetalous, polycarpellate plants, the *Ebenales, Ericales* and *Primulales,* and the latter have developed the

dicarpellate orders *Gentianales, Polemoniales, Scrophulariales* and *Lamiales,* constituting a series which shows diminishing numbers of stamens, carpels and seeds, and increasing zygomorphy. This phyletic sequence from *Ranales* to *Lamiales* constitutes the sub-class *Strobiloideae,* or cone-flowers.

Returning again to the *Ranales,* we find that they give rise to the simpler, cotyloid, apopetalous, polystemonous, polycarpous, hypogynous *Rosales* (sub-class *Cotyloideae*), from which by the early deepening of the cotyloid structure we have the mostly polystemonous, polycarpous, epigynous *Myrtales, Loasales* and *Cactales* as a strongly developed side line. The oligostemonous *Celastrales* continue the main phyletic line with reducing numbers of stamens, carpels and seeds, and a gradual deepening of the cup, to the side-line of the *Sapindales,* which are eventually epigynous, and the mostly dicarpellate *Umbellales.* The sympetalous, epigynous *Rubiales* with reduced calyx, few carpels and few seeds, pass easily into the *Campanulales,* and the *Asterales,* the latter with but one seed in the dicarpellary, one-celled, one-seeded, inferior ovary, and with its calyx, when not obsolete, transformed into bracts, spines or bristles to form a "pappus" for the efficient distribution of the seeds.

II. Taxonomy of Flowering Plants

Phylum XIV. **ANTHOPHYTA**. The Flowering Plants.

Typically chlorophyll-green plants (a few colorless hysterophytes), ranging from small or even minute plants to great trees a hundred or more meters in height; alternation of generations obscured by the extreme reduction of the gametophyte to a condition of dependence upon the long-lived, leafy-stemmed sporophyte. Spores of two kinds (heterosporous), produced on sporophylls which are borne in modified, often much reduced strobili (flowers); microsporophylls (stamens) normally with four sporangia (pollen sacs); the microspores being set free (as "pollen") when mature; megasporophylls (carpels) folded lengthwise (constituting the "pistil") enclosing the sporangia (ovules) in which the megaspores

remain and develop the minute gametophyte; archegones very much reduced, including little more than the egg, which is

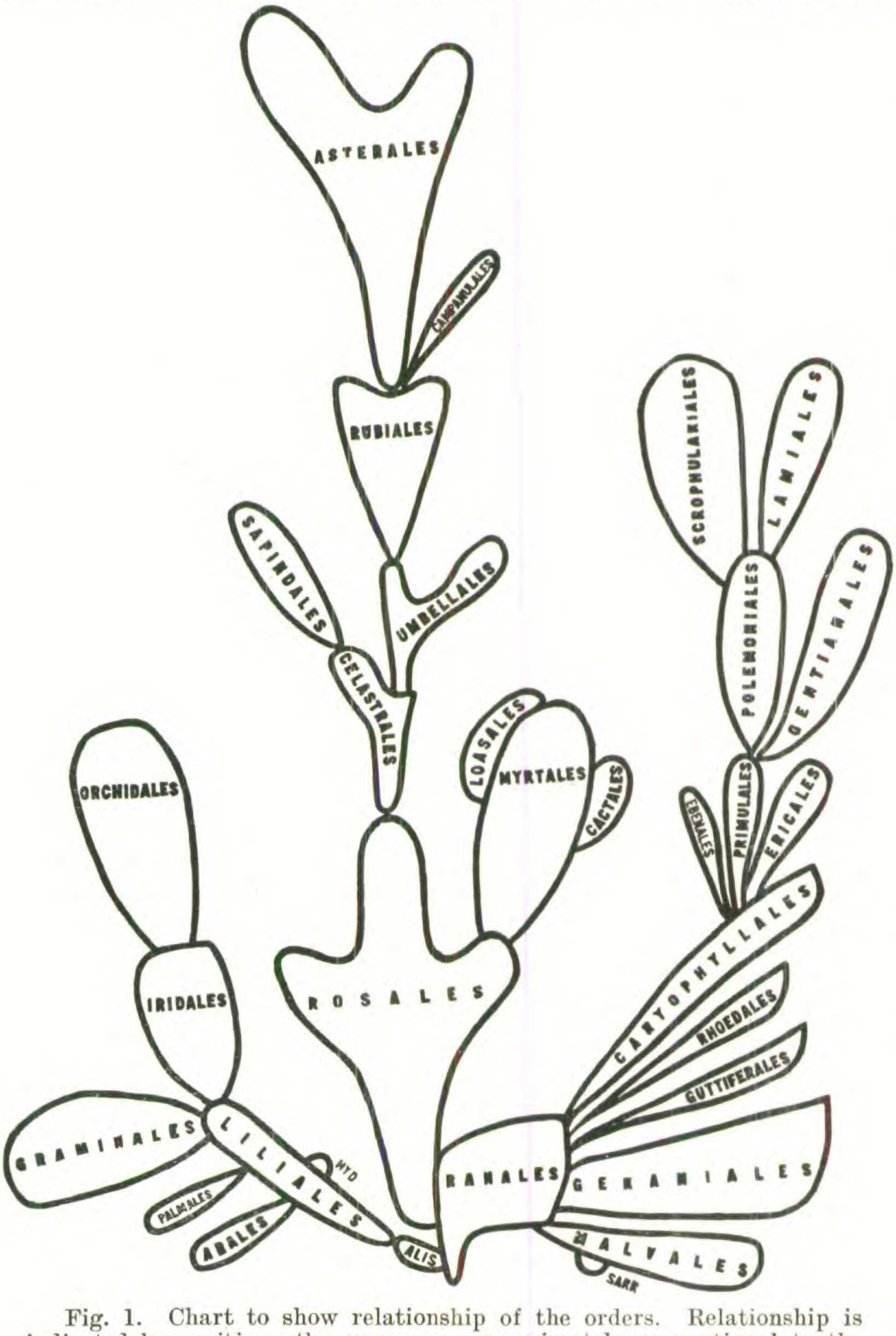

Fig. 1. Chart to show relationship of the orders. Relationship is indicated by position; the areas are approximately proportional to the number of species in the orders.

fecundated by the non-ciliated sperms (male nuclei) from the tubular antherids, resulting in the formation of an embryo

sporophyte; megasporangia surrounded by one or two enveloping indusial coats (seed coats); mature seed with or without endosperm (gametophyte tissue).

The flowering plants are here held to have sprung from cycadean strobiliferous ancestors, probably of the general type of the *Bennettitineae*, and as a consequence those anthophyta are considered to be primitive in which the sporophylls are many and distinct. Symphylly and syncarpy are later structural conditions than apophylly and apocarpy. So also, fewer sporophylls in the anthostrobilus is a later condition derived from the earlier polyphyllous structure. The symphysis of sporophylls is a mode of evolution, and so is their aphanisis.

The plants constituting this phylum are those commonly termed angiosperms, in contrast with the gymnosperms, including the cycads (*Cycadophyta*) and conifers (*Strobilophyta*). It appears to the writer, however, that these are more properly three pretty distinct phyla, and that the relationship of the gymnosperms to the angiosperms is so remote that the treatment here given them is more nearly in accordance with what is known as to their phylogeny.

There are two classes, *Alternifoliae* (monocotyledons) and *Oppositifoliae* (dicotyledons), of which the second was quite certainly the earlier, as it is now much the larger numerically. Indeed, it is becoming more probable that the monocotyledons are to be regarded as a peculiar side branch which sprang from the primitive dicotyledons after the latter had become well established. Yet the monocotyledons have not developed to as high a rank in any of their orders as have some of the dicotyledons.

Although I have here changed the technical names of these two classes, there is no objection to the retention of the old terms for the English names in popular usage: accordingly on the following pages I shall frequently make such use of the old names.

Class 32. ALTERNIFOLIAE (MONOCOTYLEDONEAE). The Monocotyledons. Leaves of young sporophyte

alternate; leaves of mature sporophyte alternate, and usually parallel-veined; fibro-vascular bundles of the stem scattered, usually not arranged in rings. (Species about 23,700.)

Sub-Class ALTERNIFOLIAE-STROBILOIDEAE. Axis of the flower from spheroidal to flattened, bearing on its surface the hypogynous perianth and stamens (or the stamens may be attached to the perianth), and the many or few, superior, separate or united carpels.

Order ALISMATALES. Carpels separate, superior to all other parts of the flower; endosperm scanty or none (species about 409). Related to and probably derived from the *Ranales* of the dicotyledons.

Family 1. **Alismataceae**. Water Plantains. Aquatic or paludose herbs with mostly radical, often large leaves; flowers small to large; perianth in two whorls of three leaves each (calyx and corolla); placenta sutural; ovules mostly solitary. *Alisma, Sagittaria.* (Pf. **2**[1]: 227.)[1]

Family 2. **Butomaceae.** Aquatic or paludose herbs, bearing narrow or broad leaves, with convergent veins; flowers large; perianth in two whorls, of three leaves each (calyx and corolla); placenta parietal; ovules many. *Butomus, Limnocharis.* (Pf. **2**[1]: 232.)

Family 3. **Triuridaceae.** Very small, pale, leafless plants growing in wet places in tropical countries. *Triuris.* (Pf. **2**[1]: 235.)

Family 4. **Scheuchzeriaceae.** Aquatic or paludose herbs with rush-like leaves, and small flowers, with a two-whorled perianth, each 4–6-parted. *Triglochin, Scheuchzeria.* (Pf. **2**[1]: 222.)

Family 5. **Typhaceae.** Cat-tails. Aquatic or paludose herbs, with linear, sheathing leaves and cylindrical-crowded flowers; pistil 1-celled; ovule 1. *Typha.* (Pf. **2**[1]: 183.)

Family 6. **Sparganiaceae.** Aquatic or paludose plants with creeping rootstocks and erect stems, bearing linear

[1] The abbreviation "Pf." has reference to Engler and Prantl's 'Natürlichen Pflanzenfamilien,' and the bold face, exponent, and Roman figures following refer respectively to "Abteilung," "Teil," and page of this publication.

leaves; flowers monoecious in dense globose heads. *Sparganium.* (Pf. **2**[1] : 192.)

Family 7. **Pandanaceae.** Screw-pines. Shrubs or trees with spirally crowded, narrow, stiff leaves on the ends of the branches; pistil 1-celled; ovules one or many. *Pandanus.* (Pf. **2**[1] : 186.)

Family 8. **Aponogetonaceae.** Aquatic plants with petioled, oblong, translucent leaves, with convergent veins; flowers small, spicate. *Aponogeton.* (Pf. **2**[1] : 218.)

Family 9. **Potamogetonaceae.** River-weeds. Aquatic or paludose herbs with mostly alternate stem-leaves; flowers mostly small and inconspicuous; perianth none, or of 1–6 leaves in 1 or 2 whorls. *Potamogeton, Zostera, Zannichellia.* (Pf. **2**[1] : 194.)

Order Liliales. Carpels united (usually 3), forming a compound pistil, superior; perianth (usually of 6 parts) in two similar whorls, delicate and corolla-like; endosperm copious. (Species about 3370.)

Family 10. **Liliaceae.** The Lilies. Pistil mostly 3-celled; stamens 6; perianth of two similar whorls, each of three similar leaves. *Lilium, Erythronium, Tulipa, Yucca, Asparagus, Allium.* (Pf. **2**[5] : 10.)

Family 11. **Stemonaceae.** Pistil 1-celled; stamens 4; perianth of two similar whorls, each of two similar leaves. *Stemona, Croomia.* (Pf. **2**[5] : 8.)

Family 12. **Pontederiaceae.** Aquatic herbs with 3 or 1-celled pistil; stamens 6 or 3; perianth of two similar whorls, each of three similar or dissimilar leaves. *Pontederia, Heteranthera.* (Pf. **2**[4] : 70.)

Family 13. **Cyanastraceae.** Tropical African rhizomatous plants. *Cyanastrum.* (Syllabus, 141.)[1]

Family 14. **Philydraceae.** Pistil 3-celled; stamen 1; perianth of two similar whorls, each of two dissimilar leaves. *Philydrium.* (Pf. **2**[4] : 75.)

[1] "Syllabus" has reference to Engler and Gilg's 'Syllabus der Pflanzenfamilien,' and the numbers following refer to pages of this publication.

Family 15. **Commelinaceae.** Spiderworts. Succulent herbs with 3 or 2-celled pistil; stamens 6; perianth of two dissimilar whorls of three similar leaves. *Commelina, Tradescantia.* (Pf. **2**^{4}: 60.)

Family 16. **Xyridaceae.** Rush-like plants with a 1-celled or incompletely 3-celled pistil; stamens 3; perianth of two dissimilar whorls, each of three similar leaves. *Xyris.* (Pf. **2**^{4}: 18.)

Family 17. **Mayacaceae.** Slender, creeping, moss-like plants with 1-celled pistil; stamens 3; perianth of two dissimilar whorls, each of three similar leaves. *Mayaca.* (Pf. **2**^{4}: 16.)

Family 18. **Juncaceae.** Rushes. Herbs with narrow leaves; pistil 1–3-celled; ovules solitary or many; fruit a dry 3-valved pod. *Juncus, Luzula.* (Pf. **2**^{5}: 1.)

Family 19. **Eriocaulonaceae.** Rush-like herbs with flowers in close heads; perianth segments 6 or less, small; pistil 3 or 2-celled; ovules orthotropous, pendulous. *Eriocaulon.* (Pf. **2**^{4}: 21.)

Family 20. **Thurniaceae.** South American herbs, with small, 1-nerved leaves, and small axillary flowers. *Thurnia.* (Syllabus, 139.)

Family 21. **Rapateaceae.** Tall, sedge-like marsh herbs with 3-celled pistil; stamens 6, in pairs; perianth of two dissimilar whorls, each of three similar leaves. *Rapatea.* (Pf. **2**^{4}: 28.)

Family 22. **Naiadaceae.** Slender, branching, wholly submerged aquatics, with sheathing, mostly opposite leaves, and monoecious or dioecious flowers. *Naias.* (Pf. **2**^{1}: 214.)

Order Arales. Compound pistil, mostly tricarpellary, superior; ovules one or more; perianth reduced to scales or entirely wanting; endosperm usually present. (Species about 1052.)

Family 23. **Cyclanthaceae.** Mostly herbaceous plants with broad, petioled leaves having parallel venation; pistil 1-celled; ovules many, on four parietal placentae. *Cyclanthus.* (Pf. **2**^{3}: 93.)

Family 24. **Araceae.** Arums. Mostly herbaceous plants with broad, petioled leaves, having reticulate venation; pistil 1–4-celled; ovules 1 or more. *Anthurium, Acorus, Monstera, Symplocarpus, Calla, Philodendron, Calocasia, Caladium, Arum, Arisaema.* (Pf. $\mathbf{2}^3$: 102.)

Family 25. **Lemnaceae.** Duckweeds. Very small, floating, aquatic herbs; pistil 1-celled; ovules 1 or more. *Lemna, Spirodela.* (Pf. $\mathbf{2}^3$: 154.)

Order Palmales. Compound pistil mostly tricarpellary, superior; ovule solitary; perianth reduced to rigid or herbaceous scales; endosperm copious. (Species about 1085.)

Family 26. **Palmaceae.** Palms. Trees or shrubs with pinnate or palmate leaves; pistil 1–3-celled; fruit a 1-seeded berry or drupe (rarely 2–3-seeded). *Phoenix, Chamaerops, Calamus, Oreodoxa, Cocos.* (Pf. $\mathbf{2}^3$: 1.)

Order Graminales. Compound pistil reduced to 2 or 3 carpels; ovule solitary; perianth reduced to small scales or entirely wanting; endosperm copious. (Species about 5795.)

Family 27. **Restionaceae.** Rush-like herbs or undershrubs, with spiked, racemed, or panicled mostly diclinous flowers; perianth segments 6 or less, chaffy; pistil 1–3-celled; ovules orthotropous, pendulous. *Restio.* (Pf. $\mathbf{2}^4$: 3.)

Family 28. **Centrolepidiaceae.** Small rush-like herbs with mostly monoclinous flowers in spikes or heads; perianth none; pistil 1–several-celled; ovules orthotropous, pendulous. *Centrolepis.* (Pf. $\mathbf{2}^4$: 11.)

Family 29. **Flagellariaceae.** Erect or climbing herbs with long narrow leaves, and panicled flowers; pistil 3-celled; ovules solitary, anatropous, ascending; fruit a 1–2-seeded berry. *Flagellaria.* (Pf. $\mathbf{2}^4$: 1.)

Family 30. **Cyperaceae.** Sedges. Grass-like herbs with 3-ranked leaves; perianth segments bristly or none; pistil 1-celled; ovules anatropous, erect. *Cyperus, Scirpus, Fimbristylis, Rhynchospora, Carex.* (Species 1959.) (Pf. $\mathbf{2}^2$: 98.)

Family 31. **Poaceae.** Grasses. Mostly erect herbs with hollow, jointed stems, and 2-ranked leaves; perianth segments

of 2–6 scales or vestiges; pistil 1-celled; ovules anatropous, ascending. *Bambusa, Bromus, Triticum, Bouteloua, Avena, Agrostis, Phalaris, Oryza, Panicum, Andropogon, Zea.* (Species 3545.) (Pf. 2^2 : 1.)

In the *Poaceae* the hypogynous, tricarpellary monocotyledons reach their culmination, as a highly specialized side line. In grasses the specialization involves plant-body, inflorescence, and flowers. Their nodose, mostly hollow, elongated stems, and long, narrow, tough leaves; the spreading paniculate arrangement of their spikelets; and their 1-celled, tricarpellary 1-ovuled pistils, producing caryopsis-fruits, are some of the more obvious indications of high specialization, suggesting the possibility that these plants, rather than the orchids, are the highest of the monocotyledons. With the *Poaceae* the hypogynous monocotyledonous phylum ends. Grasses have not given rise to other groups of plants.

Sub-Class ALTERNIFOLIAE - COTYLOIDEAE. Axis of the flower normally expanded into a cup, bearing on its margin the perianth and stamens (or the latter may be attached to the perianth). The carpels are thus inferior. Flowers from actinomorphic to zygomorphic.

Order Hydrales. Flowers diclinous; compound tricarpellary pistil inferior to all other parts of the flower; perianth segments in each whorl alike in shape (flower regular); seeds without endosperm. (Species about 53.)

Family 32. **Vallisneriaceae.** Tape-grasses. Small aquatic herbs mostly inhabiting the fresh waters of temperate climates. *Vallisneria, Hydrocharis, Philotria.* (Pf. 2^1 : 238.)

Order Iridales. Compound tricarpellary pistil inferior; flower-leaves in each whorl mostly alike in shape (flower regular, actinomorphic); seeds with endosperm. (Species about 4419.)

Family 33. **Amaryllidaceae.** Amaryllises. Leaves narrow, or the blade broad, with longitudinal veins; pistil 3-celled; ovules many; stamens 6 or 3. *Amaryllis, Crinum, Narcissus, Agave, Hypoxis.* (Pf. 2^5 : 97.)

Family 34. **Haemodoraceae.** Leaves sword-shaped; pistil 3-celled; ovules 1 to many; stamens 6. *Haemodorum.* (Pf. $\mathbf{2}^5$: 92.)

Family 35. **Iridaceae.** Leaves sword-shaped; pistil 3-celled; ovules many; stamens 3. *Crocus, Iris, Tigridia, Sisyrinchium, Ixia, Tritonia, Gladiolus, Freesia.* (Pf. $\mathbf{2}^5$: 137.)

Family 36. **Velloziaceae.** Woody-stemmed, leafy plants, with a 3-celled pistil containing many ovules, stamens 6 or more. *Vellozia.* (Pf. $\mathbf{2}^5$: 125.)

Family 37. **Taccaceae.** Stemless herbs, with broad pinnately parallel-veined leaves; pistil 1-celled; ovules many; stamens 6. *Tacca.* (Pf. $\mathbf{2}^5$: 127.)

Family 38. **Dioscoreaceae.** Yams. Mostly twining herbs, with broad, petioled, longitudinally-veined leaves; pistil 3-celled; ovules 2 in each cell; stamens 6. *Dioscorea, Testudinaria.* (Pf. $\mathbf{2}^5$: 130.)

Family 39. **Bromeliaceae.** Pineapples. Leaves mostly rosulate; external perianth whorl calycine; pistil 3-celled; ovules many; stamens 6. *Tillandsia, Dendropogon, Ananas.* (Pf. $\mathbf{2}^4$: 32.)

Family 40. **Musaceae.** Bananas. Large herbs, the stem often composed of the sheathing leaf-bases; perianth petaloid of 6, often dissimilar segments; stamens 6; pistil 3-celled; ovules 1 to very many. *Strelitzia, Musa.* (Pf. $\mathbf{2}^6$: 1.)

Family 41. **Zingiberaceae.** Gingers. Perennial, medium-sized herbs, with creeping or tuberous rootstocks; perianth irregular; stamen 1, anther 2-celled, with several "staminodes"; pistil 3-celled; ovules 1 or more in each cell. *Curcuma, Zingiber, Amomum.* (Pf. $\mathbf{2}^6$: 10.)

Family 42. **Cannaceae.** Cannas. Perennial herbs of medium size, with simple pinnately-veined leaves; perianth irregular; stamen 1, anther 1-celled, with several "staminodes"; pistil 3-celled; ovules 1 to many. *Canna.* (Pf. $\mathbf{2}^6$: 30.)

Family 43. **Marantaceae.** Perennial herbs of variable habit; leaves parallel or pinnately veined; perianth irregular; functional stamen 1, with several "staminodes"; pistil 3-

celled; ovules 1 in each cell. *Calathea, Maranta.* (Pf. 2^6: 33.)

Order ORCHIDALES. Compound tricarpellary pistil inferior; flower-leaves in each whorl mostly unlike in shape (flower irregular, zygomorphic); seeds numerous, minute, without endosperm. (Species about 7578.)

Family 44. **Burmanniaceae.** Flowers irregular; stamens 3 or 6. *Burmannia.* (Pf. 2^6: 44.)

Family 45. **Orchidaceae.** Orchids. Flowers irregular; stamens 1 or 2. *Cypripedium, Orchis, Platanthera, Vanilla, Spiranthes, Epidendrum, Dendrobium, Oncidium.* (Species 7521.) (Pf. 2^6: 52.)

In the *Orchidales,* and especially in the *Orchidaceae,* we have what is generally regarded as the highest development of monocotyledonous plants, and yet it must be acknowledged that many of their most striking flower structures are rather easily made entomophilous modifications of the perianth, the most mobile portion of the plant. In many ways the "grassy" plants (especially the *Poaceae*) show greater and more profound structural modifications than do the much more conspicuous orchids. With the orchids the epigynous monocotyledonous phylum ends.

Class 33. OPPOSITIFOLIAE (DICOTYLEDONEAE). The Dicotyledons. Leaves of young sporophyte opposite; leaves of mature sporophyte opposite or alternate, usually reticulate-veined; fibrovascular bundles of the stem in one or more cylindrical layers. (Species about 108,800.)

As indicated above the dicotyledons are here considered to have had their beginning earlier than the monocotyledons, which must be regarded as having diverged very early from the primitive dicotyledons, and developed into a relatively small lateral branch. The point of divergence of the monocotyledons from the dicotyledons must have been in the order *Ranales,* probably in the neighborhood of the *Ranunculaceae.* It is not probable that the early (woody) magnoliads or anonads gave rise to the monocotyledonous divergence; it is much more probable that this modification arose after the reduction had taken place from the ligneous to the herbaceous *Ranales.*

Here we have a possible explanation of the marked herbaceousness of monocotyledons as contrasted with the general tendency toward a more ligneous structure in dicotyledons.

Sub - Class OPPOSITIFOLIAE - STROBILOIDEAE. "Cone flowers." Axis of the flower normally cylindrical, spherical, hemispherical or flattened, bearing on its surface the hypogynous perianth, stamens and pistils (or the stamens may be attached to the corolla).

Super - Order STROBILOIDEAE-APOPETALAE-POLYCARPELLATAE. Carpels typically many, separate or united; petals separate. Flowers mostly actinomorphic. This super-order has much in common with the *Alismatales*, and also with the *Cotyloideae-Apopetalae*. In fact, these three groups appear to have diverged from a common point of origin.

Order RANALES. All parts of the flower mostly spirally arranged (acyclic), free (not united); carpels typically many, separate (or rarely united), rarely reduced to 1; stamens generally indefinite; embryo mostly small, in copious endosperm. (Species about 5551.)

The twenty-four families here included in the order *Ranales* naturally group themselves about three centers, the magnolias (*Magnoliaceae*), the anonas (*Anonaceae*), and the buttercups (*Ranunculaceae*). The plants in these centers are typically diplochlamydeous, polycarpellate, hermaphrodite, and actinomorphic, and the modifications in the surrounding families have been such as to result in an achlamydeous structure, which may be monocarpellate, diclinous, and even zygomorphic. Ranalean evolution has thus been one of more and more marked simplification of flower structure.

It is interesting to observe that while the families of *Ranales* have thus been evolved, the order has given rise to no less than five phyletic groups of full ordinal rank. One of these (*Malvales*) has produced a further modification (*Sarraceniales*), for three of them the evolutionary development came to a stand-still with the ordinal limits (*Geraniales, Guttiferales* and *Rhoedales*), while the virile *Caryophyllales* continued a development beyond its ordinal limits into the *Ebenales, Eri-*

cales and *Primulales*, and through the latter into *Gentianales*, *Polemoniales* and *Scrophulariales* to the end of this phyletic line in the *Lamiales*.

Family 46. **Magnoliaceae.** Magnolias. Petals present, usually many; receptacle usually elongated; shrubs and trees with alternate leaves and usually large flowers. *Magnolia*, *Liriodendron*. (Pf. **3**^{2}: 12.)

Family 47. **Calycanthaceae.** Petals present, usually many; seeds without endosperm; shrubs with opposite leaves. *Calycanthus*. (Pf. **3**^{2} : 92.)

Family 48. **Monimiaceae.** Petals absent; carpels many, 1-ovuled, embedded in the receptacle; trees and shrubs with opposite or whorled leaves, and diclinous flowers. *Kibara*, *Monimia*, *Siparuna*. (Pf. **3**^{2} : 94.)

Family 49. **Cercidiphyllaceae.** Trees with naked dioecious flowers, many stamens, and a single whorl of 2–5 free carpels. *Cercidiphyllum*. (Pf. **3**^{2} : 21.)

Family 50. **Trochodendraceae.** Trees and shrubs with naked flowers, many stamens, and a single whorl of 5 to many partly connate carpels. *Trochodendron*. (Pf. **3**^{2} : 21.)

Family 51. **Leitneriaceae.** Shrubs with alternate leaves and dioecious flowers in catkins; perianth minute or 0; pistil 1-celled, 1-ovuled; endosperm minute. *Leitneria*. (Pf. **3**^{1} : 28.)

Family 52. **Anonaceae.** Papaws. Petals present, in two whorls of 3 each; stamens and carpels many; endosperm ruminated; trees or shrubs with alternate leaves. *Asimina*, *Anona*. (Pf. **3**^{2} : 23.)

Family 53. **Lactoridaceae.** Much-branched shrubs of the South Pacific Islands, with alternate leaves, and apetalous flowers. *Lactoris*. (Pf. **3**^{2} : 19.)

Family 54. **Gomortegaceae.** Large trees of South America, with opposite evergreen leaves, and acyclic flowers; carpels 2–3, each with 1 ovule. *Gomortega*. (Pf. Nachträge zu Teil II–IV, 172.)

Family 55. **Myristicaceae.** Nutmegs. Sepals 3; petals absent; pistil 1 (or a second rudiment), 1-seeded; endosperm

ruminated; trees or shrubs with alternate leaves and small, inconspicuous, dioecious flowers. *Myristica.* (Pf. **3**^{2} : 40.)

Family 56. **Saururaceae.** Rhizomatous marsh herbs, with alternate leaves; flowers perfect, small, spicate; perianth 0; carpels 3–4, more or less united. *Saururus.* (Pf. **3**^{1} : 1.)

Family 57. **Piperaceae.** Peppers. Herbs, shrubs, and trees with alternate (or opposite) leaves; flowers perfect or diclinous, mostly spicate; perianth 0; pistil 1-celled, 1-ovuled; endosperm present. *Piper, Macropiper.* (Pf. **3**^{1} : 3.)

Family 58. **Lacistemaceae.** Tropical American shrubs and trees with alternate leaves, and perfect flowers; perianth mostly 0; stamen 1; pistil 3 or 2-carpellary. *Lacistema.* (Pf. **3**^{1} : 14.)

Family 59. **Chloranthaceae.** No perianth whatever; pistil 1, with 1 ovule; mostly tropical trees and shrubs, with opposite leaves, and small flowers. *Chloranthus.* (Pf. **3**^{1} : 12.)

Family 60. **Ranunculaceae.** Buttercups. Petals present in one whorl, or absent; sepals mostly deciduous; stamens and carpels indefinite, the latter usually separate; mostly herbs with alternate leaves. *Myosurus, Ranunculus, Anemone, Clematis.* (Pf. **3**^{2} : 43.)

Family 61. **Lardizabalaceae.** Petals and sepals 6 each; stamens 6; twining or erect shrubs, with alternate leaves. *Akebia, Lardizabala.* (Pf. **3**^{2} : 67.)

Family 62. **Berberidaceae.** Barberries. Petals usually present, in 1–3 whorls; stamens few; carpel 1 (rarely more), with many ovules; mostly shrubs with alternate leaves and perfect flowers. *Podophyllum, Berberis.* (Pf. **3**^{2} : 70.)

Family 63. **Menispermaceae.** Moonseeds. Petals present, in 2 whorls; carpels 3 or more; twining shrubs with alternate leaves and small dioecious flowers. *Menispermum, Cocculus.* (Pf. **3**^{2} : 78.)

Family 64. **Lauraceae.** Laurels. Aromatic trees and shrubs with alternate simple leaves and small flowers; petals 0; carpel 1; ovule 1, pendulous; endosperm 0. *Cinnamomum, Persea, Ocotea, Umbellularia, Sassafras, Litsea, Laurus.* (Pf. **3**^{2} : 106.)

Family 65. **Nelumbaceae.** Lotuses. Large aquatic herbs with peltate leaves, large acyclic flowers, with many stamens, and many separate carpels, the latter immersed in the flattish axis ("receptacle"); seeds 1 or 2, endosperm 0. *Nelumbo.* (Pf. $\mathbf{3}^2 : 1.$)

Family 66. **Cabombaceae.** Water-shields. Small aquatic herbs with floating, sometimes peltate leaves, and few to many stamens, and separate carpels (not immersed); seeds 2 or 3; endosperm present. *Cabomba, Brasenia.* (Pf. $\mathbf{3}^2 : 2.$)

Family 67. **Ceratophyllaceae.** Aquatic herbs with verticillate, divided leaves; flowers diclinous; perianth 0; stamens 12–16; carpel 1, 1-ovuled; endosperm scanty. *Ceratophyllum.* (Pf. $\mathbf{3}^2 : 10.$)

Family 68. **Dilleniaceae.** Petals present, in one whorl; sepals persistent; stamens numerous, indefinite; carpels from many to 1, with 1 or more seeds; endosperm copious; mostly shrubs and trees with alternate leaves, and perfect flowers. *Dillenia, Actinidia.* (Pf. $\mathbf{3}^6 : 100.$)

Family 69. **Winteranaceae.** Aromatic trees with alternate leaves; flowers perfect; sepals 4–5; petals 4–5 (or 0); stamens 20–30; pistil 2–5-carpellary, with as many parietal placentae; endosperm copious. *Winterana, Cinnamodendron.* (Pf. $\mathbf{3}^6 : 314.$)

Order MALVALES. Pistil usually of 3 to many weakly united carpels, with as many cells (sometimes greatly reduced); ovules mostly few; stamens indefinite, monadelphous, branched, or by reduction separate and few; endosperm present or absent. (Species about 3829.)

Family 70. **Sterculiaceae.** Trees and shrubs with alternate leaves; flowers perfect or diclinous, with or without petals; stamens monadelphous or polyadelphous, 2-celled; pistil 4–many-celled; endosperm present or 0. *Theobroma, Sterculia.* (Pf. $\mathbf{3}^6 : 69.$)

Family 71. **Malvaceae.** Mallows. Herbs, shrubs, and trees with alternate leaves; flowers perfect, with petals; stamens monadelphous, 1-celled; pistil 5–many-celled; endosperm little

or 0. *Abutilon, Althaea, Malva, Hibiscus, Gossypium.* (Pf. **3**[6]: 30.)

Family 72. **Bombacaceae.** Tropical trees with alternate, palmate leaves; sepals and petals present; staminal column 5–8-cleft. *Adansonia, Bombax.* (Pf. **3**[6]: 53.)

Family 73. **Scytopetalaceae.** Trees of the southern hemisphere, with alternate leathery leaves; sepals small; petals much larger, valvate; stamens many. *Scytopetalum.* (Pf. Nachträge zu Teil II–IV, 242.)

Family 74. **Chlaenaceae.** Madagascar trees and shrubs with alternate leaves; inflorescence dichotomous; petals contorted. *Rhodochlaena, Leptochlaena.* (Pf. **3**[6]: 168.)

Family 75. **Gonystylaceae.** East Indian trees with leathery, evergreen leaves, pentamerous flowers, and a berry-like fruit. *Gonystylus.* (Pf. Nachträge zu Teil II–IV, 231.)

Family 76. **Tiliaceae.** Lindens. Trees, shrubs (and herbs) with mostly alternate leaves; flowers mostly perfect, with petals; stamens free, 2-celled; pistil 2–10-celled; endosperm present or 0. *Corchorus, Tilia, Grewia.* (Pf. **3**[6]: 8.)

Family 77. **Elaeocarpaceae.** Tropical trees and shrubs, with alternate or opposite simple leaves; sepals and petals present; stamens distinct, many; pistil of 2–several carpels. *Elaeocarpus, Aristotelia.* (Pf. **3**[6]: 1.)

Family 78. **Balanopsidaceae.** Australian trees and shrubs with alternate leaves; flowers dioecious, apetalous, the staminate in catkins, the pistillate solitary, producing acorn-like, 2-celled, 2-seeded fruits; seeds endospermous. This family is doubtfully given place here, and it may be that it should be placed near the *Fagaceae,* as is done by Baillon. *Balanops.* (Pf. Nachträge zu Teil II–IV, 114.)

Family 79. **Ulmaceae.** Elms. Trees and shrubs with alternate, simple leaves, small apetalous flowers, a 1-celled (rarely 2-celled) ovary, which develops into a samara, drupe or nut. *Ulmus, Celtis, Zelkova, Planera.* (Pf. **3**[1]: 59.)

Family 80. **Moraceae.** Figs. Trees, shrubs, and herbs, mostly with a milky juice, and alternate or opposite leaves;

flowers apetalous, diclinous (monoecious or dioecious); ovary 1-celled, 1-ovuled. *Morus, Toxylon* (*Maclura*), *Broussonetia, Dorstenia, Artocarpus, Castilloa, Antiaris, Ficus, Humulus, Cannabis.* (Pf. **3**[1]: 66.)

Family 81. **Urticaceae.** Nettles. Herbs, shrubs, and trees with alternate or opposite leaves; flowers mostly diclinous, apetalous; stamens few, 2-celled; pistil monocarpellary, 1-celled, mostly 1-seeded; endosperm none. *Urtica, Boehmeria.* (Pf. **3**[1]: 98.)

Order Sarraceniales. Pistil of 3–5 carpels united; placentae parietal or central; seeds small, numerous, endospermous; herbs with "insectivorous" leaves; related to the mallows, with which they should possibly be included. (Species about 66.)

Family 82. **Sarraceniaceae.** Pitcher-plants. Herbs with pitcher-shaped leaves, and perfect flowers; sepals 4–5; petals 5, rarely 0; stamens indefinite; pistil 3–5-carpellary. *Sarracenia, Darlingtonia.* (Pf. **3**[2]: 244.)

Family 83. **Nepenthaceae.** Pitcher-plants. Tropical undershrubs with pitcher-shaped leaves and dioecious flowers; sepals 4 or 3; petals 0; stamens 4–16; pistil 4–3-carpellary. *Nepenthes.* (Pf. **3**[2]: 253.)

Order Geraniales. Pistil of several (5–2) mostly weakly united carpels; ovules 1–2 (or many), mostly pendulous, attached at the inner angle of the carpel. (Species about 9268.)

Family 84. **Geraniaceae.** Geraniums. Herbs, shrubs, and trees, with opposite or alternate (compound or simple) leaves; torus elongated; stamens 10; pistil mostly 5-celled; ovules few; endosperm sparse or 0. *Geranium, Pelargonium, Erodium.* (Pf. **3**[4]: 1.)

Family 85. **Oxalidaceae.** Sorrels. Herbs, rarely shrubs or trees, the juice sour; leaves mostly 3 or more foliate; flowers pentamerous, regular; stamens 10; ovules many; endosperm fleshy. *Oxalis.* (Pf. **3**[4]: 15.)

Family 86. **Tropaeolaceae.** Nasturtiums. Succulent, prostrate or climbing herbs, with alternate, peltate leaves, and

irregular, long-peduncled, spurred flowers; stamens 8; ovary tricarpellary; ovules solitary; endosperm 0. *Tropaeolum.* (Pf. **3**[4]: 23.)

Family 87. **Balsaminaceae.** Touch-me-nots. Succulent herbs, mostly erect, with opposite or alternate leaves, and irregular, spurred axillary flowers; stamens 5; ovary pentacarpellary, ovules many; endosperm 0. *Impatiens.* (Pf. **3**[5]: 383.)

Family 88. **Limnanthaceae.** Succulent marsh herbs, with alternate, pinnate leaves; flowers pentamerous; stamens 10; carpels 5; endosperm 0. *Limnanthes.* (Pf. **3**[5]: 136.)

Family 89. **Linaceae.** Flaxes. Herbs and shrubs, with alternate simple leaves; pistil 3–5-celled; endosperm fleshy (or rarely 0). *Linum.* (Pf. **3**[4]: 27.)

Family 90. **Humiriaceae.** Trees with alternate simple leaves; pistil 5–7-celled; endosperm copious. *Humiria, Saccoglottis.* (Pf. **3**[4]: 35.)

Family 91. **Erythroxylaceae.** Shrubs and trees, with mostly alternate, simple leaves; flowers pentamerous; stamens 10; ovary 3–4-carpellary; fruit a drupe; endosperm fleshy. *Erythroxylon.* (Pf. **3**[4]: 37.)

Family 92. **Zygophyllaceae.** Herbs and shrubs with usually opposite, compound leaves; pistil lobed, 4–5-celled; endosperm copious (or rarely 0). *Zygophyllum, Guaiacum, Larrea.* (Pf. **3**[4]: 74.)

Family 93. **Cneoraceae.** Shrubs with alternate entire leaves, trimerous or tetramerous flowers; pistil 3 or 4-celled, each cell with one ovule; endosperm fleshy. *Cneorum.* (Pf. **3**[4]: 93.)

Family 94. **Rutaceae.** Oranges. Herbs, shrubs, and trees with glandular-dotted, opposite, simple, or compound leaves; pistil lobed, 4–5-celled; endosperm fleshy or 0. *Xanthoxylum, Ruta, Dictamnus, Ptelea, Limonia, Citrus.* (Pf. **3**[4]: 95.)

Family 95. **Simarubaceae.** Trees and shrubs with generally alternate, non-glandular, simple, or compound leaves; pistil lobed, 1–5-celled; endosperm fleshy or 0. *Simaruba, Quassia, Holacantha, Ailanthus.* (Pf. **3**[4]: 202.)

Family 96. **Burseraceae.** Balsamic trees and shrubs with alternate compound leaves; pistil 2–5-celled; endosperm 0. *Protium, Canarium, Bursera.* (Pf. **3**[4]: 231.)

Family 97. **Meliaceae.** Trees and shrubs with alternate compound leaves; pistil 3–5-celled; endosperm present or 0. *Swietenia, Melia.* (Pf. **3**[4]: 258.)

Family 98. **Malpighiaceae.** Trees and shrubs with usually opposite, simple or lobed leaves; pistil tricarpellary; endosperm 0. *Stigmatophyllon, Malpighia, Byrsonima.* (Pf. **3**[4]: 41.)

Family 99. **Trigoniaceae.** Climbing shrubs with opposite simple leaves and irregular flowers; pistil tricarpellary; seeds many, endospermous. *Trigonia.* (Pf. **3**[4]: 309.)

Family 100. **Vochysiaceae.** Shrubs and trees with opposite or whorled leaves; sepals 5; petals 1, 3, or 5; stamens several, usually but one fertile; pistil tricarpellary; seeds few; endosperm 0. *Vochysia, Qualea.* (Pf. **3**[4]: 312.)

Family 101. **Polygalaceae.** Herbs, shrubs, and trees with alternate leaves; flowers irregular; sepals 5; petals 3–5; stamens usually 8; ovary 2-celled; ovules solitary; endosperm present or 0. *Polygala, Xanthophyllum.* (Pf. **3**[4]: 323.)

Family 102. **Tremandraceae.** Small shrubs with alternate, opposite, or whorled leaves; flowers regular; sepals and petals 3, 4, or 5 each; stamens twice as many; ovary 2-celled; ovules mostly solitary; endosperm fleshy. *Tremandra, Tetratheca.* (Pf. **3**[4]: 320.)

Family 103. **Dichapetalaceae.** Trees and shrubs with alternate simple leaves; pistil 2–3-celled; endosperm 0. *Dichapetalum, Tapura.* (Pf. **3**[4]: 345.)

Family 104. **Euphorbiaceae.** Spurges. Herbs, shrubs, and trees, mostly with a milky juice and alternate or opposite leaves; flowers diclinous, with a perianth of 1 or 2 whorls, or wanting; stamens 2-celled, free or united; pistil usually 3-celled; ovules mostly solitary; endosperm copious. *Euphorbia, Pedilanthus, Phyllanthus, Croton, Mallotus, Acalypha, Ricinus, Jatropha, Manihot, Stillingia.* (Species 4319.) (Pf. **3**[5]: 1.)

Family 105. **Callitrichaceae.** Floating herbs with opposite sessile leaves; flowers diclinous, sessile in the leaf-axils; perianth none; stamens 1 or 2; ovary 2-celled; endosperm fleshy. *Callitriche.* (Pf. **3**^{5}: 120.)

Order GUTTIFERALES. Pistil mostly of 2 or more carpels, 2–several-celled, with axile placentae; stamens usually indefinite; endosperm usually wanting. (Species about 3138.)

Family 106. **Theaceae.** Teas. Trees and shrubs usually with alternate leaves; inflorescence various; petals imbricated; seeds few; endosperm scanty or 0. *Thea, Stuartia.* (Pf. **3**^{6}: 175.)

Family 107. **Cistaceae.** Herbs and shrubs with opposite (or alternate) leaves; sepals 3–5; petals 5; stamens many; pistil 3–5-carpellary, with as many parietal placentae; seeds usually many, endospermous. *Cistus, Helianthemum, Hudsonia.* (Pf. **3**^{6}: 299.)

Family 108. **Guttiferaceae.** Trees, shrubs, and rarely herbs, with opposite or whorled, glandular-dotted leaves; inflorescence often trichotomous, with flowers mostly diclinous; petals 2–6, or more, imbricated or contorted; stamens many; carpels mostly 3–5; endosperm 0. *Hypericum, Mammea, Clusia, Garcinia.* (Pf. **3**^{6}: 194.)

Family 109. **Eucryphiaceae.** Evergreen trees of the southern hemisphere, with opposite leaves; flowers large, tetramerous; stamens many; pistil many-celled; seeds endospermous. *Eucryphia.* (Pf. **3**^{6}: 129.)

Family 110. **Ochnaceae.** Tropical shrubs and trees with alternate, coriaceous, simple leaves; pistil lobed, 1–10-celled; endosperm fleshy or 0. *Ochna.* (Pf. **3**^{6}: 131.)

Family 111. **Dipterocarpaceae.** Tropical, resiniferous trees and shrubs with alternate leaves; inflorescence panicled; flowers regular, perfect; petals contorted; fruiting calyx enlarged, and wing-like; carpels few (3–1); seeds 2 in each cell; endosperm 0. *Dipterocarpus.* (Pf. **3**^{6}: 243.)

Family 112. **Caryocaraceae.** Tropical trees and shrubs, with alternate trifoliate leaves, large showy flowers, and many

long stamens; seeds solitary; endosperm scanty or 0. *Caryocar.* (Pf. **3**^{6} : 153.)

Family 113. **Quiinaceae.** South American trees and shrubs, with opposite or whorled simple leaves; sepals 4–5; petals 4–5; stamens 15–30. *Quiina.* (Pf. **3**^{6} : 165.)

Family 114. **Marcgraviaceae.** Tropical trees and shrubs, with alternate, simple leaves; sepals 2–6; petals as many; stamens as many or more; ovary 3–5-celled; seeds many; endosperm 0. *Marcgravia.* (Pf. **3**^{6} : 157.)

Family 115. **Flacourtiaceae.** Mostly tropical trees and shrubs with alternate leaves; sepals 2–15; petals 10–0; stamens indefinite; carpels 2–10; seeds endospermous. *Pangium, Flacourtia, Samyda.* (Pf. **3**^{6a} : 1.)

Family 116. **Bixaceae.** Tropical shrubs with alternate leaves; sepals 3–7; petals large; stamens indefinite; pistil bicarpellary; seeds endospermous. *Bixa.* (Pf. **3**^{6} : 307.)

Family 117. **Cochlospermaceae.** Tropical trees and shrubs with alternate lobed or compound leaves; petals large; stamens indefinite; pistil 3–5-carpellary; endosperm copious. *Cochlospermum.* (Pf. **3**^{6} : 312, and Nachträge zu Teil II–IV, 251.)

Family 118. **Violaceae.** Violets. Herbs and shrubs with alternate (or opposite) leaves; sepals and petals 5, irregular; stamens 5; pistil 3-carpellary with 3 parietal placentae; endosperm copious. *Rinorea, Hybanthus, Viola.* (Pf. **3**^{6} : 322.)

Family 119. **Malesherbiaceae.** South American branching herbs or undershrubs, with perfect, regular, pentamerous flowers; endosperm fleshy. *Malesherbia.* (Pf. **3**^{6a} : 65.)

Family 120. **Turneraceae.** Tropical herbs and shrubs with alternate leaves; flowers perfect; sepals and petals dissimilar; stamens definite; ovary tricarpellary; endosperm copious. *Turnera.* (Pf. **3**^{6a} : 57.)

Family 121. **Passifloraceae.** Passion flowers. Climbing herbs and shrubs (a few trees) with alternate leaves; flowers perfect, regular; sepals and petals similar, distinct; stamens definite; ovary free; endosperm fleshy. *Adenia, Passiflora.* (Pf. **3**^{6a} : 69.)

Family 122. **Achariaceae.** South African herbs and undershrubs, related to the *Passifloraceae;* but with the petals united. *Acharia.* (Pf. **3**[6a]: 92.)

Family 123. **Caricaceae.** Papaws. Succulent-stemmed tropical trees, mostly with palmate leaves and milky juice; flowers pentamerous; fruit a many seeded berry; endosperm fleshy. *Carica.* (Pf. **3**[6a]: 94.)

Family 124. **Stachyuraceae.** Asiatic shrubs and trees with alternate leaves; sepals 4; petals 4; stamens 8; endosperm fleshy. *Stachyurus.* (Pf. **3**[6]: 192.)

Family 125. **Koeberliniaceae.** Leafless, thorny Texan and Mexican shrubs, with tetramerous flowers; pistil bicarpellary; seeds many; endosperm scanty. *Koeberlinia.* (Pf. **3**[6]: 319.)

Order Rhoeadales. Pistil of 2 or more united carpels, mostly 1-celled, with parietal placentae; stamens indefinite or definite; endosperm none or copious. (Species about 2856.)

Family 126. **Papaveraceae.** Poppies. Mostly milky-juiced plants, with alternate leaves, and regular or irregular flowers; sepals 2–3; petals 4 or more (or 0); stamens indefinite; pistil many-carpellary; seeds usually many; endosperm fleshy. *Eschscholtzia, Sanguinaria, Argemone, Papaver, Bicuculla, Fumaria.* (Pf. **3**[2]: 130.)

Family 127. **Tovariaceae.** Annual herbs of the tropics, with alternate leaves; 8-merous flowers, and many seeds, with scanty endosperm. *Tovaria.* (Pf. **3**[2]: 207.)

Family 128. **Nymphaeaceae.** Water-lilies. Aquatic herbs with floating leaves, and regular flowers; petals present, in 1–many whorls (really acyclic); pistils closely united; seeds many, endospermous. *Victoria, Castalia, Nymphaea.* (Pf. **3**[2]: 1.)

Family 129. **Moringaceae.** Trees of the tropics, with decompound leaves and pentamerous, zygomorphic flowers, and producing bean-like tricarpellary pods; endosperm 0. *Moringa.* (Pf. **3**[2]: 242.)

Family 130. **Resedaceae.** Mignonettes. Herbs and shrubs with scattered leaves and zygomorphic flowers; sepals 4–8

(or 2 or 0); stamens 3–40; pistil 2–6-carpellary; seeds many; endosperm 0. *Reseda.* (Pf. 3^2: 237.)

Family 131. **Capparidaceae.** Capers. Herbs, shrubs, and trees with alternate or opposite leaves, and regular or irregular flowers; sepals 4; petals 4 (or 0); stamens 4 (or many); pistil 2–6-carpellary, endosperm 0. *Cleome, Capparis.* (Pf. 3^2: 209.)

Family 132. **Brassicaceae.** Mustards. Herbs, rarely shrubs, with alternate (or opposite) leaves, and regular flowers; sepals 4; petals 4; stamens 6 or 4; pistil 2-carpellary; endosperm 0. *Sinapis, Brassica, Raphanus, Bursa, Alyssum.* (Pf. 3^2: 145.)

Order Caryophyllales. Pistil usually of 3 or more united carpels, mostly 1-celled, with a free-central placenta, and many ovules (sometimes reduced to a one-celled, one-ovuled ovary); stamens as many or twice as many as the petals; flowers regular; seeds mostly endospermous, usually with a curved embryo. (Species about 4330.)

The general arrangement of the families of the order *Caryophyllales* may be understood by placing the *Caryophyllaceae* centrally at the base; from this, one line runs off to the diplochlamydeous, hermaphrodite *Frankeniaceae* and *Tamaricaceae* to the achlamydeous, diclinous *Salicaceae,* while on the other hand another line passes from the diplochlamydeous, many-ovuled *Caryophyllaceae* to the apetalous, 1-ovuled *Amaranthaceae, Chenopodiaceae* and *Polygonaceae.*

Family 133. **Caryophyllaceae.** Pinks. Herbs (and shrubs) with opposite leaves; petals 3–5, stalked or not; ovules many on a central placenta; seeds endospermous. *Silene, Lychnis, Dianthus, Alsine, Paronychia, Illecebrum.* (Pf. 3^{1b}: 61.)

Family 134. **Elatinaceae.** Small marsh herbs or undershrubs, with small, opposite or whorled leaves; inflorescence axillary; petals imbricated; stamens 4–10; endosperm 0. *Elatine.* (Pf. 3^6: 277.)

Family 135. **Portulacaceae.** Purslanes. Herbs, or somewhat woody plants, usually somewhat succulent, with alternate or opposite leaves; sepals usually 2; petals 4–5; seeds many, endospermous. *Claytonia, Portulaca.* (Pf. 3^{1b}: 51.)

Family 136. **Aizoaceae.** Herbaceous or shrubby plants with mostly opposite or verticillate, often fleshy leaves; calyx tetramerous or pentamerous; corolla often wanting; ovary mostly 2–5-celled with few to many ovules in each cell; seeds endospermous. *Mollugo, Sesuvium, Mesembrianthemum.* (Pf. 3^{1b}: 33.)

Family 137. **Frankeniaceae.** Herbs and undershrubs with opposite leaves, and perfect flowers; petals 4–5, long-stalked; ovules many, on 2–4 parietal placentae; seeds endospermous. *Frankenia.* (Pf. 3^{6}: 283.)

Family 138. **Tamaricaceae.** Tamarixes. Shrubs and herbs with minute, alternate, deciduous leaves and mostly racemose, perfect flowers; petals 5; ovules many, on 2–5 parietal placentae; seeds hairy-tufted; endosperm 0. *Tamarix.* (Pf. 3^{6}: 289.)

Family 139. **Salicaceae.** Willows. Shrubs and trees with large alternate leaves and racemose flowers; perianth 0; ovules many, on 2–4 parietal placentae; seeds hairy-tufted; endosperm 0. Here regarded as reduced, dioecious, apetalous, *Tamaricaceae. Salix, Populus.* (Pf. 3^{1}: 29.)

Family 140. **Podostemonaceae.** Riverweeds. Small aquatic, sometimes thallose, plants; flowers perfect or diclinous; perianth 0; pistil 1–3-celled; ovules many, centrally attached; endosperm 0. *Podostemon.* (Pf. 3^{2a}: 1.)

Family 141. **Hydrostachydaceae.** Large tuber-forming Madagascar plants, with naked, dioecious flowers, single stamens, and numerous ovules on 2 parietal placentae; endosperm 0. *Hydrostachys.* (Pf. 3^{2a}: 22.)

Family 142. **Phytolaccaceae.** Pokeweeds. Herbs, shrubs, and trees with usually alternate leaves; petals 0 (or 4–5); carpels several, distinct or nearly so, 1-ovuled; seeds endospermous. *Phytolacca.* (Pf. 3^{1b}: 1.)

Family 143. **Basellaceae.** Herbaceous climbing plants, with mostly alternate leaves; calyx dimerous; corolla pentamerous; stamens 5; ovary tricarpellary, 1-celled, with one ovule; endosperm scanty. *Basella, Boussingaultia.* (Pf. 3^{1a}: 124.)

Family 144. **Amaranthaceae.** Amaranths. Herbs, shrubs (and trees) with opposite or alternate leaves, and regular, mostly perfect flowers; perianth of scarious sepals; petals 0; ovules 1 or more, basal, campylotropous; endosperm copious. *Celosia, Amaranthus, Froelichia.* (Pf. 3^{1a}: 91.)

Family 145. **Chenopodiaceae.** The Goosefoots. Herbs, shrubs (and trees) with mostly alternate leaves, and regular, perfect or imperfect flowers; perianth of herbaceous sepals; petals 0; ovule 1, basal, campylotropous; endosperm fleshy. *Beta, Chenopodium, Spinacia, Atriplex, Sarcobatus, Salsola.* (Pf. 3^{1a}: 36.)

Family 146. **Polygonaceae.** Buckwheats. Herbs, shrubs, and trees with mostly alternate leaves and regular, perfect flowers; perianth often petaloid; petals 0; pistil tricarpellary, 1-celled; ovule 1, erect, orthotropous; endosperm copious. *Eriogonum, Rumex, Rheum, Polygonum, Fagopyrum, Coccoloba.* (Pf. 3^{1a}: 1.)

Family 147. **Nyctaginaceae.** Four o'clocks. Herbs and rarely shrubs and trees, with opposite or alternate leaves; flowers mostly perfect; petals 0; sepals often petaloid; pistil seemingly monocarpellary; ovule 1, erect; endosperm copious to scanty. *Mirabilis, Bougainvillea, Allionia.* (Pf. 3^{1b}: 14.)

Family 148. **Cynocrambaceae.** Annual, succulent herbs, with petioled leaves, opposite below, alternate above; flowers monoecious, apetalous, small, axillary; pistil monocarpellary; endosperm fleshy. *Cynocrambe.* (Pf. 3^{1a}: 121.)

Family 149. **Batidaceae.** Maritime shrubs with opposite fleshy leaves and small, dioecious flowers; petals 0; ovary 4-celled; ovule solitary, erect; endosperm 0. Very doubtfully placed here. *Batis.* (Pf. 3^{1a}: 118.)

Super-Order STROBILOIDEAE-SYMPETALAE-POLYCARPELLATAE. Carpels typically many, united; petals united. Flowers actinomorphic.

Order EBENALES. Flowers regular, perfect, or diclinous; stamens mostly isomerous with, and opposite to, the corolla-lobes, or in several series; ovary 2–many-celled; seeds mostly

solitary or few, usually large, centrally attached. (Species about 1136.)

Family 150. **Sapotaceae.** Sapodillas. Tropical trees and shrubs with a milky juice, and mostly alternate leaves; flowers mostly perfect; sepals and petals 4–8 each; stamens in 2–3 whorls, attached to the corolla; ovary superior, several-celled; endosperm from fleshy to 0. *Achras, Sideroxylon, Chrysophyllum, Mimusops.* (Pf. **4**[1]: 126.)

Family 151. **Ebenaceae.** Ebonies. Tropical and subtropical trees and shrubs, with very hard wood, and mostly alternate leaves; flowers mostly dioecious; sepals and petals 3–7 each; stamens usually many and free from the corolla; ovary 3–many-celled, superior; endosperm copious. *Diospyros, Maba.* (Pf. **4**[1]: 153.)

Family 152. **Symplocaceae.** Tropical and subtropical trees and shrubs, with mostly perfect flowers; sepals usually 5; petals usually 5; stamens many, attached to the base of the corolla; ovary 2–5-celled, inferior; seeds few, endospermous. *Symplocos.* (Pf. **4**[1]: 165.)

Family 153. **Styracaceae.** Styraxes. Trees and shrubs of warm climates with alternate leaves; flowers mostly perfect, sepals and petals 5 each; stamens usually many, attached to the base of the corolla; ovary 3–5-celled, usually inferior; seeds few, endospermous. *Halesia, Styrax.* (Pf. **4**[1]: 172.)

Family 154. **Fouquieriaceae.** Mexican shrubs with small leaves (becoming thorn-like), and panicled tubular flowers; sepals 5; petals 5, united into a tube; stamens 10–15, free; ovary tricarpellary; placenta central; seeds few; endosperm scanty. This small family is given place here with some confidence that it is much more closely related to these families than to those of the *Caryophyllales* and *Polemoniales,* with which it has been associated. *Fouquieria.* (Pf. **3**[6]: 298.)

Order Ericales. Flowers regular, perfect, pentamerous or tetramerous; stamens alternate with the corolla-lobes, and as many or twice as many; cells of the mostly superior ovary (or placentae) 2 to many; seeds minute. (Species about 1730.)

Family 155. **Clethraceae.** White alders. Shrubs and trees of warm climates, with alternate deciduous leaves and pentamerous flowers; stamens 10; pistil tricarpellary; endosperm fleshy. *Clethra.* (Pf. 4^1 : 1.)

Family 156. **Ericaceae.** Heaths. Shrubs and small trees with mostly evergreen alternate or opposite leaves; ovary typically superior (sometimes inferior), 2–10-celled; anthers usually dehiscing by an apical pore; endosperm fleshy. *Rhododendron, Kalmia, Gaultheria, Arctostaphylos, Gaylussacia, Vaccinium, Calluna, Erica.* (Pf. 4^1 : 15.)

Family 157. **Epacridaceae.** Shrubs and small trees (mostly Australian) with mostly alternate evergreen leaves; ovary superior, mostly 2–10-celled; fruit capsular or drupaceous; anthers dehiscing by a slit; endosperm fleshy. *Epacris.* (Pf. 4^1 : 66.)

Family 158. **Diapensiaceae.** Low undershrubs, with alternate evergreen leaves; ovary superior, 3-celled; fruit a capsule; anthers dehiscing by a slit; endosperm fleshy. *Diapensia, Shortia.* (Pf. 4^1 : 80.)

Family 159. **Pirolaceae.** Wintergreens. Low evergreen, or chlorophylless herbs, with pentamerous or tetramerous (rarely hexamerous) flowers; stamens twice as many as the petals; ovary 4–6-celled; endosperm fleshy. *Pirola, Chimaphila, Monotropa.* (Pf. 4^1 : 3.)

Family 160. **Lennoaceae.** Parasitic, leafless herbs; ovary superior, 10–14-carpellary, 20–28-celled; ovules solitary; anthers dehiscing by a slit; endosperm copious. *Lennoa.* (Pf. 4^1 : 12.)

Order PRIMULALES. Flowers regular, mostly perfect and pentamerous; stamens epipetalous, mostly opposite to the corolla-lobes; ovary pluricarpellary, mostly 1-celled, with a free-central placenta. (Species about 1581.)

Family 161. **Primulaceae.** Primroses. Herbs with alternate or opposite leaves; stamens attached to the upper portion of the corolla tube; pistil 2–6-carpellary, one-celled; ovules many; fruit a capsule dehiscing longitudinally from the apex,

or circumscissilely; endosperm fleshy. *Primula, Androsace, Lysimachia, Cyclamen, Dodecatheon.* (Pf. **4**[1]: 98.)

Family 162. **Plantaginaceae.** Plantains. Herbs with clustered radical leaves, or alternate or opposite stem leaves; stamens alternate with the petals; ovary mostly 2-celled; ovules many; placenta axile; fruit a capsule dehiscing circumscissilely; endosperm fleshy. *Plantago.* (Pf. **4**[3b]: 363.)

Family 163. **Plumbaginaceae.** Leadworts. Herbs with alternate or clustered leaves; stamens opposite the petals; pistil 5-carpellary, one-celled, with one basal, anatropous ovule; fruit capsular; dehiscence valvate or irregular; endosperm copious. *Plumbago, Armeria.* (Pf. **4**[1]: 116.)

Family 164. **Myrsinaceae.** Trees and shrubs with mostly alternate leaves; stamens attached to the lower part of the corolla tube; ovules usually few; fruit a drupe or berry; endosperm fleshy. *Myrsine, Ardisia.* (Pf. **4**[1]: 84.)

Family 165. **Theophrastaceae.** Tropical trees and shrubs closely related to the preceding family, and sometimes included in it, but with many ovules. *Theophrasta, Jacquinia.* (Pf. **4**[1]: 88.)

Super-Order Strobiloideae-Sympetalae-Dicarpellatae. Carpels typically two, united; petals united. Flowers mostly perfect, from actinomorphic to zygomorphic.

Order Gentianales. Corolla actinomorphic (regular), mostly pentamerous; stamens alternate with the corolla-lobes, and usually of the same number and attached to the tube; leaves opposite (rarely alternate). (Species about 4664.)

Family 166. **Oleaceae.** Olives. Shrubs and trees (rarely herbs) with mostly opposite leaves, and tetramerous flowers; corolla-lobes mostly valvate or 0; stamens 2 (or 4); ovary 2-celled; ovules 1–3; endosperm present or 0. *Syringa, Olea, Jasminum, Fraxinus.* (Pf. **4**[2]: 1.)

Family 167. **Salvadoraceae.** Mostly tropical shrubs and trees, with opposite undivided leaves, and tetramerous or pentamerous flowers; corolla-lobes imbricated; stamens 4; ovary 2-celled; ovules 2; endosperm 0. *Salvadora.* (Pf. **4**[2]: 17.)

Family 168. **Loganiaceae.** Herbs, shrubs, and trees with mostly opposite simple leaves and pentamerous or tetramerous flowers; corolla-lobes imbricated or contorted; stamens mostly 4–5; ovary 2-celled (rarely 4-celled); ovules 1–many; endosperm fleshy. *Gelsemium, Logania, Spigelia, Strychnos.* (Pf. 4^2: 19.)

Family 169. **Gentianaceae.** Gentians. Mostly herbs, with usually opposite undivided leaves and pentamerous or tetramerous flowers; corolla-lobes contorted, valvate, or induplicate; stamens 4–5; ovary bicarpellary, usually 1-celled; ovules many; endosperm copious. *Erythraea, Gentiana, Eustoma, Menyanthes.* (Pf. 4^2: 50.)

Family 170. **Apocynaceae.** Dogbanes. Milky-juiced trees, shrubs, and herbs, with opposite or whorled, simple leaves and mostly pentamerous (rarely tetramerous) flowers; corolla-lobes contorted or valvate; stamens 5 (or 4), with granular pollen; ovary 2-celled or the carpels separating; ovules many; endosperm fleshy. *Vinca, Apocynum, Nerium.* (Pf. 4^2 : 109.)

Family 171. **Asclepiadaceae.** Milkweeds. Milky-juiced herbs and shrubs, with opposite, whorled (or alternate) leaves and pentamerous flowers; corolla-lobes contorted; stamens 5, with agglutinated pollen; ovary of two separated carpels with one discoid stigma; ovules many; seeds usually comose; endosperm fleshy. *Asclepias, Enslenia, Ceropegia, Stapelia, Hoya.* (Pf. 4^2: 189.)

Order POLEMONIALES. Corolla actinomorphic, becoming somewhat zygomorphic in the later families; stamens alternate with the corolla-lobes, of the same number and attached to the corolla tube; leaves alternate (rarely opposite). (Species about 4112.)

The relationship of this order to the *Primulales,* and through it to the *Caryophyllales,* is so obvious as to make it scarcely necessary to point it out here.

Family 172. **Polemoniaceae.** Phloxes. Herbs (and shrubs) with alternate leaves (rarely opposite below); flowers pentamerous; corolla-lobes 5, contorted; ovary tricarpellary, 3-celled;

ovules 1 or more in each cell; endosperm fleshy. *Cobaea, Phlox, Gilia, Polemonium.* (Pf. 4^{3a}: 40.)

Family 173. **Convolvulaceae.** Morning-glories. Herbs (often climbing), shrubs (and trees) with alternate leaves and pentamerous flowers; corolla-limb more or less plicate (rarely imbricated); ovary 2 (3–5)-celled; ovules few; endosperm fleshy. *Evolvulus, Quamoclit, Ipomoea, Convolvulus, Cuscuta* (parasitic). (Pf. 4^{3a}: 1.)

Family 174. **Hydrophyllaceae.** Herbs with radical or alternate (rarely opposite) leaves and pentamerous flowers; corolla-lobes imbricated (or contorted); ovary 1 or incompletely 2-celled; ovules 2 or more; endosperm fleshy. *Hydrophyllum, Phacelia, Nama.* (Pf. 4^{3a}: 54.)

Family 175. **Borraginaceae.** Forget-me-nots. Herbs, shrubs, and trees with alternate leaves and pentamerous flowers; corolla-lobes imbricated (or contorted); ovary bicarpellary, 4-celled, 4-lobed; ovules solitary in each lobe; endosperm fleshy or 0. *Heliotropium, Cynoglossum, Oreocarya, Borrago, Myosotis, Mertensia, Lithospermum.* (Pf. 4^{3a}: 71.)

Family 176. **Nolanaceae.** Herbaceous or suffrutescent prostrate South American plants, with alternate, entire leaves; calyx 5-parted; corolla long funnel-shaped; stamens 5, inserted on the corolla; carpels 5, distinct or united; endosperm fleshy. *Nolana.* (Pf. 4^{3b}: 1.)

Family 177. **Solanaceae.** Nightshades. Herbs, shrubs (and trees) with alternate leaves and pentamerous, mostly regular, but sometimes irregular flowers; corolla-limb more or less plicate (rarely imbricated); ovary mostly 2-celled; ovules many; endosperm fleshy. *Lycium, Atropa, Hyoscyamus, Physalis, Capsicum, Solanum, Datura, Nicotiana, Petunia.* (Pf. 4^{3b}: 4.)

Order Scrophulariales. Corolla mostly zygomorphic (irregular or oblique); stamens fewer than the corolla-lobes, usually 4 or 2; ovules numerous; fruit mostly capsular (i. e., dehiscent). (Species about 7081.)

Family 178. **Scrophulariaceae.** Snapdragons. Herbs (or shrubs and small trees) with alternate, opposite, or whorled

leaves; ovary 2-celled with an axile placenta; seeds numerous, with endosperm. *Verbascum, Linaria, Antirrhinum, Maurandia, Collinsia, Scrophularia, Mimulus, Veronica, Digitalis, Gerardia, Castilleia, Pedicularis.* (Pf. **4**^{3b}: 39.)

Family 179. **Bignoniaceae.** Catalpas. Trees, shrubs (and herbs) with opposite or whorled leaves; ovary 1 or 2-celled with parietal or axile placentae; seeds numerous, without endosperm. *Bignonia, Catalpa, Tecoma.* (Pf. **4**^{3b}: 189.)

Family 180. **Pedaliaceae.** Mostly tropical herbs with generally opposite leaves; ovary 1, 2, or 4-celled with axile placentae; seeds 1–many, with but little endosperm. *Pedalium, Sesamum.* (Pf. **4**^{3b}: 253.)

Family 181. **Martyniaceae.** Mostly tropical herbs with generally opposite leaves; stamens 2 or 4; ovary 1-celled with projecting parietal placentae; endosperm 0. *Martynia.* (Pf. **4**^{3b}: 265.)

Family 182. **Orobanchaceae.** Broom-rapes. Leafless parasitic herbs; ovary 1-celled; placentae 4, parietal; ovules minute, numerous; endosperm fleshy. *Orobanche, Thalesia, Conopholis.* (Pf. **4**^{3b}: 123.)

Family 183. **Gesneraceae.** Tropical and subtropical herbs, shrubs (and trees) with usually opposite leaves; ovary inferior or superior, 1-celled, with 2 parietal placentae; seeds numerous; endosperm scanty or 0. *Streptocarpus, Gesnera, Gloxinia.* (Pf. **4**^{3b}: 133.)

Family 184. **Columelliaceae.** South American trees and shrubs with opposite, evergreen leaves and nearly regular flowers; stamens 2; ovary inferior, 2-celled, with an axile placenta; endosperm fleshy. *Columellia.* (Pf. **4**^{3b}: 186.)

Family 185. **Lentibulariaceae.** Bladderworts. Aquatic or marsh herbs with basal, entire or dissected leaves and irregular flowers; ovary 1-celled, with a globose basilar placenta; seeds numerous; endosperm 0. *Pinguicula, Utricularia.* (Pf. **4**^{3b}: 108.)

Family 186. **Globulariaceae.** Shrubs and undershrubs or evergreen herbs, with alternate leaves, and a terminal capitate

cluster of small irregular flowers; ovary 1-celled, with a single ovule; endosperm fleshy. *Globularia.* (Pf. 4^{3b}: 270.)

Family 187. **Acanthaceae.** Herbs (shrubs and trees) with opposite leaves; ovary 2-celled; placentae axile; fruit a dry pod which splits open vertically; seeds 2–many, without endosperm. *Thunbergia, Ruellia, Acanthus, Justicia.* (Pf. 4^{3b}:274.)

Order LAMIALES. Corolla mostly zygomorphic (irregular or oblique); stamens fewer than the corolla-lobes, usually 4 or 2; ovules mostly 2 in each carpel; fruit indehiscent. (Species about 4119.)

Family 188. **Myoporaceae.** Mostly Australasian shrubs and trees, with usually alternate leaves; flowers axillary; fruit a 1–4-seeded drupe; endosperm scanty. *Myoporum.* (Pf. 4^{3b}: 354.)

Family 189. **Phrymaceae.** Erect, perennial herbs, with opposite leaves, and small spicate flowers; calyx and corolla cylindrical, 2-lipped; stamens 4; ovary 1-celled, 1-ovuled; stigma bifid; endosperm 0. *Phryma.* (Pf. 4^{3b}: 361.)

Family 190. **Verbenaceae.** Verbenas. Herbs, shrubs, and trees, with usually opposite leaves; ovary of 2 carpels, but 2–8-celled, with 1 ovule in each cell; stigma usually undivided; endosperm scanty or 0. *Verbena, Lantana, Lippia, Tectona, Vitex.* (Pf. 4^{3a}: 132.)

Family 191. **Lamiaceae.** Mints. Mostly aromatic herbs, shrubs (and trees) with opposite or whorled leaves; ovary 4-celled, 4-lobed with 1 ovule in each cell; stigma usually bifid; endosperm scanty or 0. *Lavendula, Nepeta, Stachys, Salvia, Thymus, Mentha, Coleus.* (Pf. 4^{3a}: 183.)

With this order (*Lamiales*), and especially with this family (*Lamiaceae*), we attain the summit of the cone-flowers (*Strobiloideae*). We next return almost to the point of beginning, and there start on a new phyletic line.

Sub-Class OPPOSITIFOLIAE - COTYLOIDEAE. "Cup Flowers." Axis of the flower normally expanded into a disk or cup, bearing on its margin the perianth and stamens (or the latter may be attached to the corolla).

Super-Order COTYLOIDEAE - APOPETALAE. Petals separate. Carpels many to few, separate to united, superior to inferior. This super-order appears to have originated near the beginning of the *Strobiloideae,* and therefore the orders *Ranales* and *Rosales* are to be regarded as closely related. Their relationship to *Alismatales,* also, has already been pointed out.

Order ROSALES. Flowers cyclic, usually perfect, dichlamydeous (rarely apetalous), actinomorphic to zygomorphic (regular to irregular) and mostly pentamerous; carpels usually several to many, separate or more or less united, sometimes united with the axis-cup (rarely reduced to 1); styles usually distinct. (Species about 14261.)

Family 192. **Rosaceae.** Roses. Herbs, shrubs, and trees with mostly alternate leaves; stamens usually indefinite, on the cup-margin; carpels several to many (rarely 1), free (but they may be enclosed in the deep cup); ovules usually 2, anatropous; endosperm 0. *Potentilla, Fragaria, Spiraea, Rosa.* (Species about 2700.) (Pf. $\mathbf{3}^3$: 1.)

Family 193. **Malaceae.** Apples. Shrubs and trees with alternate leaves; stamens usually many on the cup-margin; carpels few, more or less united, and adnate to the axis-cup, so as to be "inferior"; endosperm 0. *Sorbus, Pirus, Malus, Crataegus.* (Pf. $\mathbf{3}^3$: 1, 18.)

Family 194. **Prunaceae.** Plums. Shrubs and trees with alternate leaves; stamens many, on the cup-margin; carpel one, in the bottom of the deep cup, becoming a drupe; endosperm 0. *Prunus, Amygdalus.* (Species 150.) (Pf. $\mathbf{3}^3$: 1, 50.)

Family 195. **Crossosomataceae.** Southwest North American shrubs, with small leaves and a bitter bark; sepals and petals 5 each; stamens 20 or more; carpels 3–5; seeds many, reniform; endosperm scanty. *Crossosoma.* (Pf. Nachträge zu Teil II–IV, 185.)

Family 196. **Connaraceae.** Tropical trees and shrubs with alternate compound leaves; stamens definite (5–10); pistils mostly 5, free; ovules 2, ascending, orthotropous; endosperm fleshy or 0. *Connarus, Cnestis.* (Pf. $\mathbf{3}^3$: 61.)

Family 197. **Mimosaceae.** The mimosas. Mostly tropical trees, shrubs, and herbs, with alternate mostly compound leaves; flowers actinomorphic; stamens 10 or more, usually separate; carpel 1; fruit a legume; seeds mostly without endosperm. *Acacia, Mimosa.* (Species 1483.) (Pf. **3**[3] : 70, 99.)

Family 198. **Cassiaceae.** The sennas. Mostly tropical trees, shrubs, and herbs, with alternate mostly compound leaves; flowers zygomorphic; stamens 10 or less, usually separate; carpel 1; fruit a legume; seeds with or without endosperm. *Cassia, Caesalpinia, Gleditsia, Gymnocladus.* (Species 1172.) (Pf. **3**[3] : 70, 125.)

Family 199. **Fabaceae.** The beans. Mostly herbs of temperate climates, but with many shrubs and trees; leaves alternate, mostly compound; flowers zygomorphic; stamens 10 or less, usually more or less united; carpel 1; fruit a legume; seeds usually without endosperm. *Lupinus, Medicago, Trifolium, Robinia, Astragalus, Arachis, Vicia, Pisum, Phaseolus.* (Species 6948.) (Pf. **3**[3] : 70, 184.)

This family constitutes a well-marked side-line in the order *Rosales,* with zygomorphic, entomophilous flowers. It is not obvious what relation, if any, exists between this form of the flower, and the legume structure of the fruiting carpel.

Family 200. **Saxifragaceae.** Saxifrages. Herbs with alternate leaves, regular 4 or 5-merous mostly perfect flowers, with 8 or 10 stamens, and usually 2 more or less united carpels which are superior; seeds many; endosperm copious. *Saxifraga, Heuchera, Mitella.* (Pf. **3**[2a] : 41.)

Family 201. **Hydrangeaceae.** Hydrangeas. Shrubs and trees with mostly opposite leaves, and regular 4 or 5-merous mostly perfect flowers, with few (8) to many (40) stamens, and 2–5 united carpels, which are more or less overgrown by the axis-cup; seeds many; endosperm copious. *Philadelphus, Hydrangea.* (Pf. **3**[2a] : 41.)

Family 202. **Grossulariaceae.** Gooseberries. Shrubs with alternate leaves, regular 4 or 5-merous perfect flowers, usually 5 stamens, and 2 to several united carpels which are wholly

overgrown by the fleshy cup (ovary inferior); seeds few, endosperm copious. *Ribes*. (Pf. 3^{2a}: 41.)

Family 203. **Crassulaceae.** Stonecrops. Mostly fleshy herbs, with opposite or alternate leaves and perfect flowers; stamens definite (4–10 or many); pistils several, free or little united; ovules many; placentae central or axile; endosperm fleshy. *Sedum, Cotyledon, Crassula, Penthorum*. (Pf. 3^{2a}: 23.)

Family 204. **Droseraceae.** Sundews. Gland-bearing marsh herbs with perfect flowers; stamens mostly definite (4–20); pistil syncarpous, 1–3-celled, superior; ovules many, on basal, axile, or parietal placentae; endosperm fleshy. *Drosera, Dionaea*. (Pf. 3^{2}: 261.)

Family 205. **Cephalotaceae.** Pitcher-plants. Perennial Australian herbs with a rosette of elliptic, and pipe-shaped radical leaves, and a central, erect, spicate flowering stem; flowers regular, perfect, apetalous; sepals 6; ovules solitary; endosperm copious. *Cephalotus*. (Pf. 3^{2a}: 39.)

Family 206. **Pittosporaceae.** Trees and shrubs of the southern hemisphere, with alternate leaves; sepals, petals, and stamens 5 each; ovary 2-carpellate; endosperm copious. *Pittosporum, Marianthus*. (Pf. 3^{2a}: 106.)

Family 207. **Brunelliaceae.** South American trees, with opposite or whorled leaves and diclinous flowers; sepals and petals 4–5 or 7 each; stamens twice as many; carpels usually 4–5, free; endosperm fleshy. *Brunellia*. (Pf. Nachträge zu Teil II–IV, 182.)

Family 208. **Cunoniaceae.** Shrubs and trees, mostly of the southern hemisphere, with opposite or whorled leaves and small, perfect flowers; sepals and petals 4–6 each; stamens twice as many; carpels 2–5, united; endosperm fleshy. *Belangera, Cunonia*. (Pf. 3^{2a}: 94.)

Family 209. **Myrothamnaceae.** Small, rigid, balsamic South African and Madagascar shrubs, with opposite leaves, and dioecious, achlamydeous flowers; ovary tricarpellary; seeds many, with fleshy endosperm. *Myrothamnus*. (Pf. 3^{2a}: 103.)

Family 210. **Bruniaceae.** Heath-like shrubs of the southern hemisphere, with small leaves and small, perfect, regular, pentamerous flowers; stamens definite; pistil 2–3-celled, inferior or superior; ovules 1 to many, pendulous; endosperm copious. *Brunia.* (Pf. 3^{2a} : 131.)

Family 211. **Hamamelidaceae.** Witch-hazels. Shrubs and trees with mostly alternate leaves and perfect or imperfect, mostly pentamerous flowers; stamens few or many; pistil bicarpellary, its ovary inferior; ovules solitary or many; endosperm thin. *Liquidambar, Altingia, Hamamelis.* (Pf. 3^{2a} : 115.)

Family 212. **Casuarinaceae.** Beefwood trees. Shrubs and trees with striate stems bearing whorls of reduced scale-like leaves; flowers diclinous; petals 0; pistil bicarpellary, 1-celled; ovules 2, lateral, half anatropous; endosperm 0. *Casuarina.* (Pf. 3^{1} : 16.) This family, which has puzzled botanists from the first, is doubtfully placed here, on the theory that these plants are leafless relatives of the *Hamamelidaceae.*

Family 213. **Eucommiaceae.** Chinese trees, with alternate leaves, and achlamydeous diclinous flowers; stamens 6–10; pistil bicarpellary, 1-celled, 2-seeded; endosperm present. *Eucommia.* (Pf. Nachträge zu Teil II–IV, 159.)

Family 214. **Platanaceae.** Plane-trees. Trees with alternate leaves, and monoecious flowers in globular heads; perianth 3–8-merous; stamens 3–8; pistils 3–8, each 1-celled, 1-ovuled; endosperm scanty. *Platanus.* (Pf. 3^{2a} : 137.)

Order Myrtales. Flowers usually actinomorphic (regular) or nearly so, usually perfect; pistil of united carpels, usually inferior; placentae axile or apical (rarely basal); style 1 (rarely several); leaves simple, usually entire. (Species about 7323.)

Here again we shall soon reach the end of a phyletic sideline, consisting principally of the order *Myrtales,* with the *Loasales* and *Cactales* as the ultimate branches.

Family 215. **Lythraceae.** Herbs, shrubs, and trees usually with opposite leaves and 4-angled branches; flowers mostly 4–6-merous; stamens definite (8–12), or indefinite; pistil 2–6-

celled, free; ovules numerous, on axile placentae; endosperm 0. *Lythrum, Cuphea, Lagerstroemia.* (Pf. 3^7 : 1.)

Family 216. **Sonneratiaceae.** Tropical trees with opposite leaves; ovary sunken in the axis-cup, many celled (4–15); stamens many; endosperm 0. *Sonneratia.* (Pf. 3^7 : 16.)

Family 217. **Punicaceae.** Pomegranates. Small tropical and sub-tropical trees with opposite leaves and 5–7-merous flowers; stamens many; ovary inferior, 4–15-celled, producing a pulpy, many-seeded fruit; endosperm 0. *Punica.* (Pf. 3^7 : 22.)

Family 218. **Lecythidaceae.** Tropical trees, with alternate leaves and usually 4–6-merous flowers; stamens many; ovary inferior, 2–6-celled; endosperm 0. *Barringtonia, Napoleona, Lecythis, Bertholletia.* (Pf. 3^7 : 26.)

Family 219. **Melastomataceae.** Mostly tropical herbs, shrubs, and trees with generally opposite or whorled leaves; stamens usually double the number of petals; pistil 2–many-celled, inferior; ovules minute, numerous, on axile or parietal placentae; endosperm 0. *Melastoma, Osbeckia, Rhexia, Tamonea.* (Pf. 3^7 : 130.)

Family 220. **Myrtaceae.** Myrtles. Trees and shrubs with opposite or alternate leaves, and perfect, regular flowers; stamens many; pistil 2–many-celled, inferior; ovules 2 to many; plancentae basal or axile; endosperm 0. *Myrtus, Pimenta, Eugenia, Jambosa, Eucalyptus, Malaleuca.* (Species 2556.) (Pf. 3^7 : 57.)

Family 221. **Combretaceae.** Trees and shrubs often climbing, with opposite or alternate leaves; stamens usually definite (4–10); pistil 1-celled, inferior; ovules 2–6 or solitary, pendulous; endosperm 0. *Terminalia, Combretum, Laguncularia.* (Pf. 3^7 : 106.)

Family 222. **Rhizophoraceae.** Mangroves. Mostly tropical trees and shrubs with opposite leaves and regular, 4–8-merous flowers; stamens 2–4 times the number of petals; pistil 2–6-celled, usually inferior; ovules 2, pendulous; endosperm fleshy. *Rhizophora, Carallia.* (Pf. 3^7 : 42.)

Family 223. **Oenotheraceae.** Evening primroses. Herbs (shrubs and trees) with opposite or alternate leaves, and perfect, 2–3–4-merous, regular flowers; stamens 1–8, rarely more; pistil usually 4-celled, inferior; ovules 1 to many on axile placentae; endosperm scanty or 0. *Epilobium, Anogra, Oenothera, Meriolix, Gaura, Fuchsia, Circaea.* (Pf. **3**^{7} : 199.)

Family 224. **Halorrhagidaceae.** Aquatic or terrestrial herbs with opposite or alternate leaves and perfect or imperfect, sometimes apetalous flowers; pistil 1–4-celled, inferior; ovules solitary, pendulous; endosperm present. *Halorrhagis, Myriophyllum.* (Pf. **3**^{7} : 226.)

Family 225. **Hippuridaceae.** Aquatic perennial erect herbs, with whorled leaves, and small, reduced, axillary apetalous flowers; ovary 1-celled, 1-ovuled; endosperm scanty. *Hippuris.* (Pf. **3**^{7} : 237.)

Family 226. **Cynomoriaceae.** Parasitic rhizomatous fleshy plants with spicate, small, apetalous, diclinous flowers, each with a single ovule; endosperm fleshy. *Cynomorium.* (Pf. **3**^{1} : 250.)

Family 227. **Aristolochiaceae.** Dutchman's-pipes. Herbaceous or shrubby plants, with alternate leaves and large, apetalous, perfect, irregular flowers; stamens 6, rarely more; pistil 4 or 6-celled, inferior; ovules numerous, on axile (or protruding parietal) placentae; endosperm copious. *Asarum, Aristolochia.* (Pf. **3**^{1} : 264.)

Family 228. **Rafflesiaceae.** Fleshy, parasitic herbs, of warm climates, leafless, or nearly so, with mostly imperfect flowers; petals 0, or rarely 4; stamens 8 to many; pistil 1-celled or imperfectly many-celled, inferior; ovules minute, very numerous, on parietal or pendulous, folded placentae; endosperm present. *Rafflesia, Cytinus.* (Pf. **3**^{1} : 274.)

Family 229. **Hydnoraceae.** Parasitic, succulent, tropical herbs with perfect, 3–4-merous flowers; perianth single, valvate; stamens 3–4, but anthers many; seeds very numerous; endosperm copious. *Hydnora.* (Pf. **3**^{1} : 282.)

Order Loasales. Flowers usually actinomorphic, perfect or diclinous; pistil mostly tricarpellary, 1-celled, its ovary usually inferior; placentae parietal and with many ovules; styles free or connate; leaves ample, entire, lobed or dissected. (Species about 1392.)

Family 230. **Loasaceae.** Star-flowers. Herbs (rarely climbing) with opposite or alternate leaves; flowers perfect; sepals and petals dissimilar, mostly 5 each; stamens indefinite, 5–10 or more; ovary 3–7-carpellary, 1-celled; endosperm mostly 0. *Mentzelia, Loasa.* (Pf. 3^{6a} : 100.)

Family 231. **Cucurbitaceae.** Melons. Mostly climbing or prostrate herbs and undershrubs, with alternate leaves; flowers mostly diclinous and pentamerous; stamens definite (usually 3); ovary mostly tricarpellary; endosperm 0. *Melothria, Momordica, Luffa, Citrullus, Cucumis, Lagenaria, Cucurbita.* (Pf. 4^{5} : 1.)

Family 232. **Begoniaceae.** Begonias. Mostly erect herbs with alternate leaves; flowers diclinous, more or less zygomorphic; stamens indefinite and numerous, ovary tricarpellary, 3-celled, usually 3-angular; endosperm little or 0. *Begonia.* (Pf. 3^{6a} : 121.)

Family 233. **Datiscaceae.** Herbs or large trees, with alternate leaves; flowers small, and diclinous; stamens 4 to many; ovary 3–8-carpellary; placentae on the walls; seeds small, and many; endosperm scanty. *Datisca.* (Pf. 3^{6a} : 150.)

Family 234. **Ancistrocladaceae.** Climbing plants of tropical Asia, with alternate leaves, and small, regular, perfect flowers; petals 5; stamens 5–10; ovary 1-celled, many-seeded; endosperm present. *Ancistrocladus.* (Pf. 3^{6} : 274.)

Order Cactales. Flowers actinomorphic or very slightly zygomorphic, perfect; stamens many; pistil 4–8-carpous, inferior, 1-celled, with 4–8 parietal placentae; style single, with 2 to many stigmas; endosperm scanty or 0; embryo curved. Fleshy-stemmed plants with leaves mostly small or wanting. (Species about 1168.)

Family 235. **Cactaceae.** Cactuses. Mostly natives of the warmer portions of America; from small herbs to tree-like

dimensions. *Peireskia, Opuntia, Cereus, Carnegiea, Echinocactus, Melocactus, Cactus, Rhipsalis.* (Pf. **3**^{6a} : 156.)

Order Celastrales. Receptacle often developing a glandular, annular or turgid disk, which is sometimes adnate to the pistil, in which case the pistil is more or less inferior; pistil 1 to many-celled (rarely apocarpous); ovules 1–3, pendulous or erect; endosperm present or 0. Flowers actinomorphic and mostly perfect. (Species about 2741.)

Family 236. **Rhamnaceae.** Buckthorns. Trees and shrubs often climbing, with alternate or opposite, simple leaves; petals present; disk more or less adnate to the 2–4-celled pistil; ovules 1 or 2, erect; endosperm fleshy. *Zizyphus, Rhamnus, Ceanothus, Phylica, Colletia.* (Pf. **3**^{5} : 393.)

Family 237. **Vitaceae.** Grapes. Climbing shrubs (and trees) with alternate, simple or compound leaves; petals coherent, valvate; pistil superior, 2-celled, 2-ovuled (or 3–6-celled, 1-ovuled); endosperm often ruminate. *Vitis, Parthenocissus, Cissus.* (Pf. **3**^{5} : 427.)

Family 238. **Celastraceae.** Bittersweets. Shrubs (often climbing) and trees, with usually alternate, simple leaves; petals present, imbricated; disk more or less adnate to the 2–5-celled pistil; ovules usually 2, erect or pendulous; endosperm fleshy. *Euonymus, Celastrus, Cassine.* (Pf. **3**^{5} : 189.)

Family 239. **Buxaceae.** Boxes. Evergreen shrubs and trees, with alternate or opposite leaves, and usually monoecious, small, apetalous flowers; stamens 4; pistil tricarpellary, superior; endosperm fleshy. *Pachysandra, Buxus.* (Pf. **3**^{5} : 130.)

Family 240. **Aquifoliaceae.** Hollies. Trees and shrubs, with alternate or opposite, simple leaves and small, perfect flowers; pistil superior, 3 to many-celled; ovule 1, pendulous; endosperm fleshy. *Ilex, Nemopanthes.* (Pf. **3**^{5} : 183.)

Family 241. **Cyrillaceae.** South American evergreen shrubs or small trees, with alternate leaves; sepals 5; petals 5; stamens 5–10; carpels 2–5, united, superior; endosperm fleshy. *Cyrilla.* (Pf. **3**^{5} : 179.)

Family 242. **Pentaphylacaceae.** Chinese trees, with alternate, leathery leaves and small, perfect flowers; sepals 5; petals 5; stamens 5; pistil superior, of 5 carpels, each 2-ovuled; endosperm scanty. *Pentaphylax.* (Pf. Nachträge zu Teil II–IV, 214.)

Family 243. **Corynocarpaceae.** New Zealand trees, with alternate, fleshy, leathery leaves; sepals 5; petals 5; stamens 5; pistil superior, of 2 carpels; endosperm 0. *Corynocarpus.* (Pf. Nachträge zu Teil II–IV, 215.)

Family 244. **Hippocrateaceae.** Tropical trailing and climbing woody plants with opposite leaves; sepals 5; petals 5; stamens 3 or 2 or 5; pistil of 3 carpels more or less adnate to the disk; endosperm 0. *Hippocratea, Salacia.* (Pf. **3**[5]: 222.)

Family 245. **Stackhousiaceae.** Australian herbs and shrubs with simple alternate leaves and perfect flowers; petals 5; stamens 5; ovary 2–5-celled; ovule 1 in each cell, erect; endosperm fleshy. *Stackhousia.* (Pf. **3**[5]: 231.)

Family 246. **Staphyleaceae.** Bladder-nuts. Erect shrubs and trees, with opposite, compound leaves and pentamerous perfect flowers; sepals 5; petals 5; stamens 5; pistil of 2–3 superior carpels; seeds few to many; endosperm fleshy or 0. *Staphylea, Turpinia.* (Pf. **3**[5]: 258.)

Family 247. **Geissolomataceae.** South African evergreen shrubs, with opposite sessile leaves; sepals 4; petals none; stamens 8; pistil superior, of 4 carpels, each 2-ovuled; endosperm fleshy. *Geissoloma.* (Pf. **3**[6a]: 205.)

Family 248. **Penaeaceae.** South African evergreen heath-like shrubs, with small, opposite leaves and regular, perfect flowers; petals 0; pistil superior, 4-celled; ovules 2–4, erect; endosperm 0. *Penaea.* (Pf. **3**[6a]: 208.)

Family 249. **Oliniaceae.** African shrubs and trees, with thick, leathery, opposite leaves, and small, regular, perfect flowers; sepals 4–5, large; petals 4–5, very small; stamens 4–5; pistil inferior, of 3–5 carpels; endosperm 0. *Olinia.* (Pf. **3**[6a]: 213.)

Family 250. **Thymelaeaceae.** Shrubs, small trees (and herbs), with alternate or opposite, usually coriaceous, simple

leaves and small petalous or apetalous, mostly perfect flowers; pistil superior, 1–5-carpellary, 1-celled; ovule 1, pendulous; endosperm fleshy, sparse, or 0. *Gnidia, Thymelaea, Daphne, Dirca.* (Pf. **3**^{6a} : 215.)

Family 251. **Hernandiaceae.** Tropical trees and shrubs, with alternate leaves; flowers perfect or monoecious, regular; sepals 4–10; petals none; stamens 3; pistil 1-celled, inferior; ovule 1, pendulous; endosperm 0. *Hernandia.* (Pf. **3**^{2} : 126.)

Family 252. **Elaeagnaceae.** Oleasters. White or brown-scurfy trees and shrubs, with alternate or opposite, simple leaves and perfect or diclinous flowers; petals 0; pistil 1-celled; ovule 1, ascending; endosperm 0 or scanty. *Elaeagnus, Lepargyraea.* (Pf. **3**^{6a} : 246.)

Family 253. **Myzodendraceae.** South American parasitic shrubs, with alternate, rather small leaves; flowers dioecious, apetalous; stamens 2–3; pistil 1-celled, inferior; endosperm fleshy. *Myzodendron.* (Pf. **3**^{1} : 198.)

Family 254. **Santalaceae.** Sandalwoods. Parasitic herbs, shrubs, and trees, with alternate or opposite, simple leaves and small, perfect, or diclinous flowers; epigynous; petals 0; pistil inferior, 1–5-carpellary, 1-celled; ovules 2–5, pendulous; endosperm present. *Santalum, Comandra, Thesium.* (Pf. **3**^{1} : 202.)

Family 255. **Opiliaceae.** Shrubs of tropical climates, with alternate leaves, and perfect flowers; sepals, petals and stamens 4–5 each; pistil superior, 1-celled, 1-ovuled; endosperm fleshy. *Opilia.* (Pf. Nachträge zu Teil II–IV, 142.)

Family 256. **Grubbiaceae.** South African shrubs with opposite leaves, and epigynous, apetalous flowers; ovary 2-celled; ovules 2; endosperm fleshy. *Grubbia.* (Pf. **3**^{1} : 282.)

Family 257. **Olacaceae.** Trees and shrubs, often twining, mostly tropical, with usually alternate, simple leaves and mostly perfect, apetalous flowers; pistil superior or inferior, 1–3-celled; ovules 2–3, pendulous; endosperm fleshy. *Olax.* (Pf. **3**^{1} : 231.)

Family 258. **Loranthaceae.** Mistletoes. Parasitic evergreen shrubs with opposite (or alternate) leaves, often re-

duced to bracts; flowers perfect or diclinous; petals 0; pistil 1-celled, inferior; ovule 1, erect; endosperm fleshy. *Loranthus, Viscum, Phoradendron, Razoumowskia.* (Pf. **3**[1]: 156.)

Family 259. **Balanophoraceae.** Parasitic, leafless herbs, all tropical, with much reduced, apetalous, monoecious or dioecious flowers; pistil 1-celled, inferior; ovule 1, pendulous; endosperm fleshy. *Balanophora.* (Pf. **3**[1]: 243.)

Order Sapindales. Flowers mostly actinomorphic, perfect, or diclinous; pistil 1 to several-celled, superior to inferior; ovules 1–2, erect, ascending, or pendulous; endosperm mostly 0. (Species about 2903.)

The *Sapindales* lie wholly in a phyletic side-line, and the order has been developed from some part of the intermediate order *Celastrales,* which constitutes a transition from the lower hypogynous cup flowers to those in which epigyny is fixed. In the lower *Sapindales* hypogyny still persists, but in the higher families this gives way to complete epigyny.

Family 260. **Sapindaceae.** Soapberries. Trees and shrubs, mostly tropical, with alternate (or opposite), mostly compound leaves and mostly perfect, irregular flowers; disk present or 0; petals 3–5 or 0; pistil 1–3-celled; ovules 1 or 2, ascending; endosperm usually 0. *Paullinia, Sapindus, Talisia, Litchi, Koelreuteria, Dodonaea.* (Pf. **3**[5]: 277.)

Family 261. **Hippocastanaceae.** Horsechestnuts. Trees and shrubs, with opposite, palmately compound leaves; flowers mostly regular; sepals 5; petals 4–5; stamens 8–5; pistil superior, tricarpellary; endosperm 0. *Aesculus.* (Pf. **3**[5]: 273.)

Family 262. **Aceraceae.** Maples. Trees and shrubs, with opposite, simple or compound leaves and small, regular flowers; sepals 4–10; petals as many or none; pistil superior, bicarpellary, winged in fruit; endosperm 0. *Acer.* (Pf. **3**[5]: 258.)

Family 263. **Sabiaceae.** Trees and shrubs of the tropics, with alternate, simple or compound leaves, and perfect or diclinous flowers; petals 4–5; pistil 2–3-celled; ovules 1 or 2, horizontal or pendulous; endosperm 0. *Sabia, Meliosma.* (Pf. **3**[5]: 367.)

Family 264. **Icacinaceae.** Tropical trees and shrubs, with alternate or opposite leaves and regular, perfect or diclinous flowers; sepals 5; petals 5; stamens 5; pistil superior, 1-celled, and tricarpellary; endosperm fleshy. *Icacina.* (Pf. **3**^{5} : 233.)

Family 265. **Melianthaceae.** Tropical trees and shrubs, with alternate leaves, and pentamerous, mostly perfect, zygomorphic flowers; endosperm fleshy. *Melianthus.* (Pf. **3**^{5} : 374.)

Family 266. **Empetraceae.** Heath-like shrubs, with small alternate leaves; flowers small, regular, mostly dioecious, solitary or in heads; petals present; stamens 2–3, 2–3-celled; pistil 2 to many-celled; seeds solitary, endospermous. *Corema, Empetrum.* (Pf. **3**^{5} : 123.)

Family 267. **Coriariaceae.** Shrubs with opposite, sessile leaves and perfect or diclinous flowers; 5 sepals; 5 petals; 10 stamens; 5–10 carpels, slightly united; seeds few; endosperm scanty. *Coriaria.* (Pf. **3**^{5} : 128.)

Family 268. **Anacardiaceae.** Sumachs. Trees and shrubs, mostly tropical, with alternate, usually compound leaves and small, perfect flowers; petals 3–7 or 0; pistil 1–5-celled, superior, but surrounded by the fleshy cup; ovules solitary, pendulous (or erect); endosperm 0. *Mangifera, Anacardium, Schinus, Cotinus, Metopium, Rhus.* (Pf. **3**^{5} : 138.)

Family 269. **Juglandaceae.** Walnuts. Trees and shrubs, with alternate, compound leaves and small, diclinous, apetalous flowers; pistil bicarpellary, 1-celled, adnate to the fleshy cup, and so inferior; ovule 1, erect, orthotropous; endosperm 0. *Engelhardtia, Juglans, Hicoria.* (Pf. **3**^{1} : 19.)

Family 270. **Betulaceae.** Birches. Trees and shrubs, with alternate, simple leaves, and monoecious or dioecious flowers, which are in aments; petals none; calyx small or none; stamens 2–10; pistil inferior, bicarpellary, 1–2-celled; endosperm 0. *Carpinus, Ostrya, Corylus, Betula, Alnus.* (Pf. **3**^{1} : 38.)

Family 271. **Fagaceae.** Beeches. Trees and shrubs, with alternate, simple leaves and small, diclinous flowers; petals 0; pistil mostly tricarpellary, 2–6-celled, inferior; ovules 2 in each cell, erect or pendulous; fruit usually 1-seeded; endosperm 0. *Fagus, Castanea, Pasania, Quercus.* (Pf. **3**^{1} : 47.)

Family 272. **Myricaceae.** Bayberries. Shrubs and trees, with alternate, simple leaves and small, achlamydeous, diclinous flowers; petals 0; pistil free, bicarpellary, 1-celled; ovule 1, erect, orthotropous; endosperm 0. *Myrica.* (Pf. **3**[1]: 26.)

Family 273. **Julianaceae.** Dioecious, tropical trees, with alternate leaves; flowers small, apetalous, dioecious; stamens 4–8; pistil of 3–5 carpels; endosperm 0. *Juliana.* (Pf. Nachträge zu Teil II–IV, 335, and Syllabus, 161.) This family is given place here very doubtfully.

Family 274. **Proteaceae.** Shrubs, trees (and herbs) of the southern hemisphere, with mostly alternate, simple, usually coriaceous, evergreen leaves; flowers perfect or diclinous; sepals petaloid; petals 0; stamens 4; pistil monocarpellary, 1-celled; ovule 1, erect or pendulous; endosperm little or none. *Protea, Leucadendron, Grevillea, Hakea, Banksia.* (Pf. **3**[1]: 118.) This puzzling family is given place here very doubtfully.

Order UMBELLALES. Flowers actinomorphic (regular), usually perfect, 4–5-merous; calyx small to minute; stamens usually definite (4–5); pistil syncarpous, 1 to many-celled, its ovary inferior; ovules solitary, pendulous; styles free or united at the base; endosperm copious; embryo usually minute. (Species about 2809.)

Family 275. **Araliaceae.** Aralias. Trees, shrubs (and herbs), mostly tropical, with alternate leaves; flowers in umbels, heads, or panicles; ovary 2–15-celled; fruit a berry with a fleshy or dry exocarp. *Hedera, Aralia, Panax.* (Pf. **3**[8]: 1.)

Family 276. **Apiaceae.** Parsleys. Herbs (shrubs and trees), with alternate leaves; flowers small, pentamerous, mostly umbellate; ovary 2-celled; fruit splitting into two dry indehiscent mericarps. *Hydrocotyle, Sanicula, Eryngium, Coriandrum, Conium, Apium, Cicuta, Carum, Foeniculum, Angelica, Ferula, Heracleum, Daucus.* (Species 2177.) (Pf. **3**[8]: 63.)

Family 277. **Cornaceae.** Cornels. Shrubs and trees (rarely herbs), with usually opposite leaves; flowers larger, 4–5-

merous, umbellate, capitate, or corymbose; ovary 2–4-celled, fruit drupaceous. *Garrya, Nyssa, Cornus, Aucuba.* (Pf. 3^8 : 250.)

Super-Order COTYLOIDEAE - SYMPETALAE. Petals united. Carpels few, united, inferior; stamens usually as many as the corolla-lobes, mostly attached to the corolla.

Order RUBIALES. Flowers 4–5-merous, actinomorphic (rarely zygomorphic); stamens 4–5, attached to the corolla; calyx small; ovary 2–8-celled; ovules 2 to many in each cell. (Species about 5063.)

Family 278. **Rubiaceae.** Madders. Trees, shrubs and herbs, mostly tropical, with opposite or whorled leaves; flowers usually perfect, and regular, with valvate, contorted, or imbricate corolla-lobes; carpels mostly 2; style simple, bifid, or multifid; fruit a capsule, berry, or drupe; endosperm from fleshy to 0. *Houstonia, Cinchona, Bouvardia, Cephalanthus, Randia, Coffea, Mitchella, Galium, Rubia.* (Pf. 4^4 : 1.)

Family 279. **Caprifoliaceae.** Honeysuckles. Mostly woody plants with opposite leaves; flowers usually zygomorphic, with imbricate corolla-lobes; carpels 2–5, with 1 or more pendulous ovules; style usually with a capitate undivided stigma; fruit a berry; endosperm fleshy. *Sambucus, Viburnum, Linnaea, Lonicera.* (Pf. 4^4 : 156.)

Family 280. **Adoxaceae.** Moschatels. Slender herbs with scaly rootstocks, bearing ternately compound leaves; flowers small, regular, greenish, in heads; stamens about 10; ovary 3–5-celled; fruit drupaceous; endosperm cartilaginous. *Adoxa.* (Pf. 4^4 : 170.)

Family 281. **Valerianaceae.** Valerians. Herbs (and shrubs) with opposite leaves; flowers somewhat irregular, cymose, corymbose, or solitary; stamens 1–4, the anthers free; ovary 1–3-celled, the ovules pendulous; fruit with 1 fertile cell, 1-seeded; endosperm scanty, or 0. *Valerianella, Fedia, Valeriana.* (Pf. 4^4 : 172.)

Family 282. **Dipsacaceae.** Teasels. Herbs (and shrubs) with opposite or whorled leaves; flowers zygomorphic, in

involucrate heads; stamens 2–4, the anthers free; carpels 2, but pistil 1-celled; ovule 1, pendulous; endosperm scanty. *Cephalaria, Dipsacus, Scabiosa.* (Pf. 4^4: 182.)

Order Campanulales. Flowers actinomorphic to zygomorphic; stamens mostly free, their anthers free or connate; ovary 1 to several-celled; ovules 1–8. (Species about 1539.)

Family 283. **Campanulaceae.** Bellflowers. Mostly milky-juiced herbs (shrubs and small trees), with alternate (or opposite) leaves; flowers regular or irregular; stamens usually 5, free, or more or less united; carpels 2–5; ovules many; endosperm fleshy. *Campanula, Lobelia.* (Pf. 4^5: 40.)

Family 284. **Goodeniaceae.** Mostly Australian herbs and shrubs, with alternate (or opposite) leaves; flowers usually irregular; stamens 5, free, or cohering above; ovary 2–4-celled; ovules many; endosperm fleshy. *Goodenia, Scaevola, Brunonia.* (Pf. 4^5: 70.)

Family 285. **Stylidiaceae.** Mostly Australian herbs, with tufted, radical, or scattered and sometimes crowded stem-leaves; flowers usually irregular; stamens 3–2, mostly connate with the style; ovary 2-celled, many-ovuled; endosperm fleshy. *Stylidium, Levenhookia.* (Pf. 4^5: 79.)

Family 286. **Calyceraceae.** South American herbs, with alternate leaves; flowers regular or irregular in involucrate heads; stamens attached to the corolla-tube, anthers free; ovary 1-celled; stigma capitate; ovule 1, pendulous; endosperm fleshy. *Boopis, Calycera.* (Pf. 4^5: 84.)

Order Asterales. Composites. Flowers actinomorphic or zygomorphic, collected into involucrate heads; calyx small, and often forming a "pappus"; stamens 5, epipetalous, mostly with their anthers connate, dehiscing introrsely; carpels 2, united, inferior, with one style which is 2-branched above; ovule one, erect, anatropous; endosperm 0. An immense order (commonly regarded as a family) of about 14,324 species, which are usually distributed among fourteen tribes, all of which are here raised to families. In the following arrangement the *Helianthaceae* are regarded as the lowest, from which the two principal phyletic lines have arisen, cul-

minating on the one hand in the *Eupatoriaceae,* and on the other in the *Lactucaceae.* (Pf. **4**^{5} : 87.)

Family 287. **Helianthaceae.** Sunflowers. Calyx not capillary; receptacle chaffy; usually with ray flowers; mostly large and coarse plants, with leaves usually opposite. *Helianthus, Zinnia, Rudbeckia, Silphium.* (Species 1364.) (Pf. **4**^{5} : 210.)

Family 288. **Ambrosiaceae.** Ragweeds. Calyx not capillary; receptacle chaffy; without ray flowers; mostly large and coarse plants, with leaves usually alternate, flowers diclinous. *Ambrosia, Xanthium.* (Species 74.) (Pf. **4**^{5} : 220.)

Family 289. **Heleniaceae.** False sunflowers. Calyx not capillary; receptacle usually naked; with or without rays; anthers tailless; medium-sized plants with opposite and alternate leaves. *Helenium, Gaillardia.* (Species 449.) (Pf. **4**^{5} : 251.)

Family 290. **Arctotidaceae.** Gazanias. Calyx not capillary; receptacle naked; anthers tailless. South African plants with mostly alternate leaves. *Gazania, Arctotis.* (Species 278.) (Pf. **4**^{5} : 307.)

Family 291. **Calendulaceae.** Marigolds. Calyx not capillary; receptacle naked; anthers tailed. Old World plants, mostly tropical, with alternate leaves. *Calendula.* (Species 125.) (Pf. **4**^{5} : 303.)

Family 292. **Inulaceae.** Everlastings. Calyx from bracteose to capillary; receptacle usually naked; anthers tailed; usually rayless; mostly low plants, with alternate leaves. *Inula, Antennaria, Gnaphalium, Helichrysum.* (Species 1580.) (Pf. **4**^{5} : 172.)

Family 293. **Asteraceae.** Asters. Calyx from bracteose to capillary; receptacle naked; usually with rays. Medium-sized plants, with alternate leaves. *Aster, Solidago, Erigeron, Bellis.* (Species 1815.) (Pf. **4**^{5} : 142.)

Family 294. **Vernoniaceae.** Ironweeds. Calyx from bracteose to capillary; receptacle naked; without rays; style branches hispidulous. Medium-sized plants, with mostly alternate leaves. *Vernonia.* (Species 788.) (Pf. **4**^{5} : 120.)

Family 295. **Eupatoriaceae.** Blazing-stars. Calyx from bracteose to capillary; receptacle naked; without rays; style branches papillose. Medium-sized plants, with opposite and alternate leaves. *Lacinaria, Eupatorium.* (Species 944.) (Pf. **4**^{5}: 131.)

Family 296. **Anthemidaceae.** Camomiles. Calyx a short crown or wanting; involucral bracts with scarious margins; receptacle chaffy or naked; usually with white ray flowers. Medium-sized plants, with alternate leaves. *Anthemis, Chrysanthemum, Artemisia.* (Species 915.) (Pf. **4**^{5}: 267.)

Family 297. **Senecionidaceae.** Groundsels. Calyx capillary; involucral bracts mostly 1-seriate; receptacle naked; flowers mostly yellow, with or without rays. Medium-sized to large plants, with alternate leaves. *Senecio, Arnica.* (Species 1982.) (Pf. **4**^{5}: 283.)

Family 298. **Carduaceae.** Thistles. Calyx mostly capillary; involucral bracts multiseriate; anthers tailed; receptacle usually bristly (not chaffy); without rays. Mostly stout plants, with alternate leaves. *Carduus, Arctium, Cnicus.* (Species 1563.) (Pf. **4**^{5}: 312.)

Family 299. **Mutisiaceae.** Mutisias. Calyx mostly capillary; receptacle usually naked; flowers all two-lipped. Medium to large (even woody) plants, of tropical or warm regions, with mostly alternate leaves. *Mutisia, Chaptalia.* (Species 550.) (Pf. **4**^{5}: 333.)

Family 300. **Lactucaceae.** Lettuces. Calyx mostly capillary; receptacle usually naked; flowers all strap-shaped. Small to medium-sized plants, mostly with a milky juice, and with alternate leaves. *Lactuca, Hieracium, Cichorium, Leontodon,* (*Taraxacum*). (Species 1701.) (Pf. **4**^{5}: 350.)